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FURTHER EXPERIENCE AS TO THE VALUE OF PRE-OPERATIVE IRRADIATION WITH X-RAYS OR RADIUM AND WITH PRE- AND POST-BIOPSY IRRADIATION WHILE SUBMITTING THE SECTIONS TO A NUMBER OF EXPERIENCED SURGICAL PATHOLOGISTS

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THE idea of pre-operative or pre-biopsy irradiation is not mine alone. It has been practised by others in a number of the well-known cancer clinics throughout the civilized world. Nevertheless, post-operative and post-biopsy irradiation is the rule, while, from my experience, it should be the exception.

In the "Annals of Surgery" for November, 1932, was published my article read by title before the American Surgical Association in May of that year. The full title was: When should Irradiation with Radium or X-rays Precede Operation, or be Employed without It?

In this article I quoted the work of Keynes, of St. Bartholomew's Hospital, in London, published in the "British Journal of Surgery" for February, 1932. I was much impressed not only by his contribution, but by my visit to his clinic in the previous May. His method of treating inoperable cancer of the breast by interstitial radium salt needles, as illustrated in Figure 1 of my article, was practised quite commonly by a smaller group of surgeons in London when I was there in the Spring of 1932, almost two years ago. There seemed to be no question but that a number of the cases so treated appeared to be clinically well and free from definite recurrences, and a number had passed the two- and three-year limits. I have seen one definite three-year cure in Dr. Henry's Cancer Clinic, in Regina, Canada. I have two such cases of my own—both living and apparently well to-day, three and one-half and two and one-half years, respectively, since treatment.

I published a second paper in the "Annals of Surgery" for November, 1933, the title of which was "Pre-operative Irradiation in Cancer of the Breast, with and without Biopsy." Here I confined my studies largely to recent observations in which irradiation was done, not in conjunction with operation, but as a measure preceding the complete operation and when incomplete operations were practically forced upon us by the patient's refusing, or not being physically fit for the complete operation. This paper was read for me by Dr. Max Cutler before the Congress of Radiology, held in Chicago in September, 1933.

Since returning from my visit to the cancer clinics in Paris and London, I have interested myself much more in the employment of x-rays and radium as a pre-operative and pre-biopsy measure, and have attempted to establish certain definite rules.

All recurrent tumors—whether operable or not—irrespective of their known pathology, have been given the benefit of a thorough course of irradiation, either with deep x-rays or with radium in some form. There is plenty of evidence to justify

this. For example, in small cancers of the skin, especially of the face, recurrent after any procedure, the chances of a permanent cure are reduced at least to 60 per cent by excision with a margin sufficient for the primary tumor. In a number of these cases there has been no further treatment beyond irradiation. I am convinced that this rule should be given careful consideration by operators. No harm can be done by proper irradiation in these recurrent cases which are apparently still operable.

My most recent example is as follows: Nine years ago I excised a lesion about the size of a ten-cent piece, with a margin sufficient for a primary basal-cell cancer of the face. It had been present off and on six years and had received inadequate x-ray treatment. I have just examined the sections again. The small basal-cell cancer has apparently a free margin of uninfiltrated normal tissue about it. Yet, after more than eight years of an apparently normal scar a little ulcer (about three mm. in diameter) has formed, covered with a scab. It has not healed with daily applications of warm water and soap followed by alcohol and petrolatum. It is still very small and could be excised with a margin larger than the scar without leaving an unsightly new scar. It is my opinion that the majority of my colleagues in operative surgery would operate again. But I have sufficient evidence to show that this patient's chances of a permanent cure are better with irradiation, irrespective of whether excision is performed or not, and I propose to repeatedly bring before such of my colleagues as are responsible for tumor work the idea of the rule in all recurrent tumors, irrespective of their pathologic nature (even lipoma and dermoid cysts), to give irradiation first.

There is a second recurrent tumor that establishes a new rule in regard to adamantine carcinoma of the body of the lower jaw. This patient came under observation six months ago with a scar 2.5 cm. in length, beginning 2 cm. in from the angle of the jaw. One could easily see and feel an expansion of the bone beneath this scar, and in the x-ray film one could see numerous light areas mixed with bone areas occupying the body of the jaw beneath and beyond the scar. I was also sent a section removed from this jaw in 1929, almost four years ago, and this showed an adamantine carcinoma in scar tissue. When this patient was operated upon in 1929 it was a recurrent tumor after operations in 1915 and in 1921. So it is almost twenty years since the first tumor was curetted. At each operation curetting was performed. After the operations in 1921 and 1929, x-ray therapy was given. Subsequently, as I said above, a section, obtained at the first operation, was sent to me. The microscopic picture is typical of adamantine carcinoma, without the scar tissue which predominates in the last section.

I had never observed this tumor to remain so small after so many years and so many curetting operations. The question of therapy rested between irradiation and resection of the body of the right lower jaw. In view of my new rule to try irradiation first, this patient was given a very thorough treatment according to the so-called Coutard method by Dr. Burnam and Dr. Neal, in Dr. Kelly's Radiotherapeutic Institute. Pain and tenderness were quickly relieved, and at the end of two weeks, the patient left—free of pain and convinced that he was very much improved. He returned in two months for observation, and, as the swelling had entirely disappeared and the scar felt to the patient as it had before the recurrent swelling, he was given a second course of treatment.

The attitude toward pre-operative irradiation in this case first gave the patient the benefit of a cure or a retardation of growth by irradiation alone. Furthermore, it increased the chances of complete eradication by a resection of the body of the lower jaw. I have every evidence that the delay for thorough and repeated irradiation will increase the chances of a

permanent cure. Nevertheless, I have a few examples of permanent cures after operations for recurrent adamantine carcinomas which have had no pre-operative irradiation, and in one of them the continuity of the lower jaw was preserved. It is thirteen years since this operation.

Ultimately I hope to publish in this Journal further evidence of the essential value of irradiation as the first treatment for recurrence after any type of operation for any type of tumor, even abdominal, before attempting further operative intervention.

Another rule recently formulated is to attempt irradiation first in certain operable tumors the complete removal of which means unusual mutilation, such as a cancer of the lower end of the rectum involving the sphincter. I have recently been through such an experience with Dr. Burnam at Dr. Kelly's Institute. The patient was a female aged over forty. There had been bleeding and discomfort of three months' duration. A biopsy had been done, distinctly showing an adenocarcinoma of the rectum. The ulcer was oblong in shape and the size of two twenty-five-cent pieces, so close to the sphincter that it would have been dangerous to attempt to save the sphincter. Dr. Burnam agreed to try irradiation on the same principle as for a cancer of the cervix. He applied daily for two weeks a very large amount of radium in emanation. It produced little or no discomfort, there was no irritation of the rectum, the ulcer rapidly healed (about as rapidly as a similar ulcer of the oral cavity), and the rectum is normal to-day, more than two months since the first treatment.

In a second paper I hope to bring out some strikingly favorable results after irradiation of inoperable cancers of the rectum. This was my first experience with an operable tumor.

All of us must remember that in the evolution of the irradiation treatment of cancer of the cervix it was tried first in inoperable cancer, and the results in this group were so striking that the early pioneers in a few cancer clinics throughout the civilized world attempted it next in late, but apparently operable, cancers. Then a few of them ceased operating for cancer of the cervix and substituted irradiation. The majority of authorities to-day agree that irradiation with radium and deep x-rays is the treatment that promises most in all types of cancer of the cervix, and the best results are reaching 35 per cent, varying from less than 10 to more than 90 in the four group grades of cancer of the cervix.

As in my two above-mentioned previous papers, I emphasize the great value of pre-operative and pre-biopsy irradiation of all bone tumors, and I am now including lesions of the jaw, whether they involve teeth or not, in this rule. I will not discuss this further here, because I now have in preparation an article on irradiation of bone tumors, to be presented before the fiftieth anniversary of the Memorial Hospital in New York, and if I can not publish the full article in this Journal there will be an abstract sent to the Editor.

Pre-operative and pre-biopsy irradiation of such bone tumors as are suspicious of malignancy on x-ray examination, are pretty well established. Just how long one should persist in the irradiation treatment is not yet established, but one must remember that there is danger in too long attempts, as in too short attempts.

Breast Tumors.—In the past two years, due to the increasing number of doubtful breast tumors explored for biopsy in my own clinic, and among those sent to me for diagnosis, I have been forced to take a different view of the former rule of advising the complete operation when the pathologists are in doubt as to the malignant nature of the breast tumor excised and submitted to frozen section in the operating room.

I am not yet prepared to advise irradiation before the immediate complete operation when the section shows an undoubted malignant tumor. But recently, in special cases, when we have excised the clinically doubtful tumor of very short

duration and found it to be microscopically cancer, I have, for special reasons, submitted the patient to irradiation rather than to the complete operation, and in some of these cases the complete operation has not yet been performed. This study is approaching its completion and is to be presented before the Surgical Section of the American Medical Association. I am giving here a brief abstract of this paper, which will ultimately be published in the "Journal of the American Medical Association."

Breast Tumors in which it Seems Wiser to Perform Irradiation First: Cancer en cuirasse.—This can be recognized clinically by the increased weight and the edema of the breast, the pig skin over the breast, and a very peculiar redness of the skin of the breast, whether it is involved or not with pig skin. When I contrast the results in the patients whom we first saw with cancer *en cuirasse*, and in whom the condition was distinctly inoperable, with those in more recent years in whom the condition was operable and for whom most complete operations were performed with the cautery or the electric needle, followed by post-operative irradiation, I find that the first group, when left absolutely alone, were more comfortable up to the time of death than the second group, subjected to complete operation followed by irradiation. Three and one-half years ago I asked my colleague, Dr. Max Kahn, to irradiate a patient with cancer *en cuirasse* which, although extensive, was still operable. This patient is living to-day, almost three years and six months. She suffers no discomfort; there is great improvement in the local condition.

A second case of cancer *en cuirasse*, distinctly operable, was referred to Dr. Burnam for irradiation. The weight and edema of the breast have disappeared, a distinct lump in the upper inner quadrant and a few palpable glands in the axilla have disappeared to palpation, the pig skin and erythema have almost gone. After some weeks of treatment, she began to have pain in the cervical and thoracic vertebræ, and x-ray examination revealed metastasis. The discomfort from this has been entirely relieved by the irradiation. There is no doubt but that these two patients with cancer *en cuirasse* are much more comfortable than any other two subjected to complete operation and post-operative irradiation.

In the past two years two clinically benign breast tumors have been excised because frozen sections in the operating room were diagnosed not only cancer, but graded IV, acute carcinoma. There were no clinical evidences of cancer *en cuirasse*. There was metastasis to the base and mid-glands. On account of the grading of the tumor, the electric cautery was employed in the dissection and a large area of skin removed, to be followed by grafting. Very quickly, in spite of post-operative irradiation, there developed in the skin about the grafted area first skin metastasis, then cancer *en cuirasse*. Both patients succumbed to the disease within two years, suffering greatly meanwhile. Therefore, if, at the exploratory excision, the sections of the tumor removed are definitely cancer and positively of Group IV, acute carcinoma, the wound should be cauterized with the thermal cautery and closed with drainage, and the breast, axilla, and supraclavicular area subjected at once to deep x-ray therapy, or the four-gramme pack, or some type of interstitial irradiation. I believe it is safer not to perform the complete operation in cancer *en cuirasse*.

Inoperable Cancer of the Breast.—Everyone now seems to agree that this group should be subjected to irradiation first, and that there should be one or more courses of such irradiation. (I will not discuss in this paper the methods of irradiation, except that one named for Coutard.) I have one such case, now living two years. The treatment was given by Dr. H. A. Kelly and his son and consisted in the implantation of radon seeds, following the method of Mr. Keynes, of England, in addition to radium emanations in larger amounts applied exter-

nally. Three months later we excised the breast and grafted skin. I have discussed this case in detail in two previous papers. No glands could be palpated, none were removed, because the patient was distinctly a bad operative risk. I have not seen this patient since her stormy recovery from the operation, but both the woman and her physician write me that her general health is excellent and there is no sign of recurrence. I am not confident that anything is gained by the removal of the breast with a large area of skin. As previously reported, although we found areas of cancer in the stained sections, there was no growth of cancer cells in the cell culture by Dr. and Mrs. Gey.

Pre-operative Irradiation in Operable Cancer.—As far as I can learn, the majority of surgeons of large experience prefer the complete operation without delay or within a few days after a short and, in my opinion, incomplete pre-operative irradiation. I believe to-day that when one selects pre-operative irradiation for operable, clinically distinct cancer of the breast, the irradiation should be of the same intensity and the same duration as for inoperable cancer of the breast. This is a point that can not be settled by anyone's experience to-day. I am selecting these cases among patients of extreme age, or who are very bad operative risks, or who refuse operation—it is a small group. So far, all results have been favorable. At the present time in my clinic the majority of cases of clinical cancer of the breast which are distinctly operable and clinically favorable are subjected to immediate operation. Those clinically unfavorable are irradiated first. As far as I can make out, no case irradiated first has lost any chances of a permanent cure by operation. But for comparison there must be two groups of operable cancer of the breast, clinically malignant—those operated on without pre-operative irradiation, and those with such irradiation.

Clinically Doubtful Tumors of the Breast.—In my observation this group has been increasing more than any other. As a rule, the duration of the breast symptoms has been less than one month. There is a single, definite, palpable lump, which if larger than a twenty-five-cent piece, transilluminates dark, or, if smaller, transilluminates light or doubtful. In any event, the operator feels that this palpable lump should be explored and removed (unless it proves to be a blue-domed cyst), being submitted to immediate frozen section in the operating room, when this is possible.

These tumors, distinctly benign in gross appearance and frozen section, at exploration, fall into the following classes: The common blue-domed cysts; the distinct galactoceles and chronic breast abscesses; less frequently, the intracystic papillomas, and the distinctly encapsulated fibroadenomas or intracanalicular myxomas. The type of tumor increasing to-day is the non-encapsulated solid tumor, most of which are areas of chronic cystic mastitis, and some are chronic lactation mastitis without pus. Many of these tumors are very difficult to distinguish from cancer in the frozen or permanent section, especially when the patient is pregnant or lactating. They must be placed in a group called "microscopically doubtful tumors." I have discussed them in the "Archives of Surgery" for 1921 (III, 445), and, more recently, in the "American Journal of Cancer," 1932 (XVI, 103).

The new point I wish to make is this: The majority of the microscopically doubtful tumors exposed by surgeons and surgical pathologists of average ability and experience will ultimately prove to be benign. There is little or no risk in excising such a tumor, waiting for the wound to heal, and then subjecting it to a thorough course of irradiation. During this period sections should be submitted to a number of pathologists. When there is disagreement among them, the chances are that the tumor is benign and nothing further need to be done. If the tumor is agreed upon as being malignant, the majority of surgeons to-day will prefer to follow the pre-operative irradiation by the complete

operation. And there also will be a difference of opinion how long one should wait. I am rather in favor of completing at least the first course of irradiation before undertaking the complete operation, and waiting at least two or three weeks to let the effects of the irradiation subside. This group is becoming very common in my observation, and, so far, no individual has suffered by the delay incident to the irradiation, while many breasts have been saved.

In the second group, the operator and his pathologist at the exploratory incision or excision will be of the opinion that the lump in the breast is malignant. The majority of surgeons and, I think, radiologists to-day favor that the complete operation be performed at once. I am gathering evidence which shows that nothing is lost and something very valuable to the patient may be gained by the simple removal of the tumor in such cases, to be followed by irradiation of the same type and for the same period as for a clinically malignant tumor.

I find that there is considerable difference of opinion among radiotherapists as to the period of time between the excision of the tumor only and the irradiation. My associate, Dr. Curtis Burnam, is inclined to wait a couple of weeks, giving the wound a chance to heal. It is true, the wound is apt not to heal when irradiated at once, and Dr. Burnam fears an infection which will interfere with irradiation. We have tried both immediate and postponed irradiation. I am rather inclining to the immediate irradiation, especially in a smaller group of cases in which the sections show definite malignancy.

This entire problem of irradiation in operable malignant tumors of the breast is unsettled and needs much further study. I wish to emphasize that when a breast tumor is clinically benign and when, at operation, it is microscopically doubtful, the tumor should be excised with a margin of healthy breast tissue, the wound closed, and there should be immediate irradiation while waiting for the section to be submitted to a number of pathologists. This irradiation should continue on the supposition that the tumor is malignant. If ultimately the pathologists disagree or conclude that it is non-malignant, nothing more need be done. If they conclude that it is malignant, it is the responsibility of the surgeon to choose between further irradiation and the complete operation.

I am rather inclined to the view that ultimately it will be irradiation.

COMBINED SURFACE AND INTERSTITIAL RADIATION IN THE TREATMENT OF MAMMARY CANCER[1]

By ALBERT SOILAND, M.D., *Los Angeles*

RADIATION therapy—that ever-changing, ever-progressing, and always fascinating branch of medical science—demands new recognition as a therapeutic arm of major importance in the management and treatment of cancer of the breast. This disease, since its earliest recognition, has been considered as a purely surgical problem. This viewpoint, however, is now being challenged from observers in different parts of the world. From the Continent, several well-known radiologists assure us that either x-rays or radium, applied according to their own particular method of procedure, gives results which are equal to, or better than, those reported by surgery. While the significance of this opinion has not yet been accepted openly in America, there are, nevertheless, a considerable number of individuals here who are slowly but surely forcing upon their surgical confrères a realization that both x-rays and radium are, at least, strong allies of, if not actual substitutes for, surgery in the treatment of this devastating disease.

The most recent report of Hermann Wintz,[2] one of the staunch supporters of radiation therapy at Erlangen, Germany, gives results in the treatment of carcinoma of the breast by x-rays alone over a period of fifteen years, and presents conclusions which demand the attention of all those interested in carcinoma of the breast. It would appear to the open-minded that Wintz has secured sufficient evidence from his work to place his results on a parity with, or even better than, those obtained in the best of surgical circles. In fact, Howard C. Taylor, Jr., who reviews[3] his work, states in conclusion:

"This paper is an important one on account of the large number of cases, the invariable microscopic proof of diagnosis, and the manner in which the statistics have been compiled. Wintz himself is conservative in the statement of his conclusions, although he points to the superior results obtained in Groups II and III (Steinthal) to those obtained in surgery. Nevertheless, one cannot but conclude that, can the figures of Wintz be duplicated in other clinics, the simple surgical treatment of breast cancer will have difficulty in maintaining its present position. However, such duplication has yet to be observed.

"The emphasis upon the unreliability of statistics on breast cancer as compared to uterine cancer, in which the principle of reporting five-year cures on the basis of all cases observed (absolute cure rate) has been universally adopted, appears very pertinent."

So much for the x-ray side of the question. Now let us cross the Channel and observe what one of our British colleagues, Geoffrey Keynes, says on "The Radium Treatment of Carcinoma of the Breast,"[4] as ably abstracted by Howard C. Taylor, Jr.[5]

"The problem in the treatment of carcinoma of the breast by radium is exactly the same as in the operative treatment: how completely to extirpate the cells of the primary growth and all secondary growths that may conceivably be accessible. The correct principles for surgery, which are now standardized, are removal of (1) the whole mammary gland with the overlying skin for as great a distance as possible around the primary growth, (2) the underlying fascia and pectoral muscles, (3) the axillary lymph nodes and the channels from the breast in continuity. Attempts to extend the operation further, while occasionally successful, are too dangerous for general applicability.

"Until recently most radiation treatment was confined to inoperable cases, and the London Radium Institute was able to report that 11 out of 98 of these cases, hopeless as far as surgery was concerned, survived for five years. Keynes' attempt to treat carcinoma

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

[2] Deutsche med. Wchnschr., 1931.

[3] Am. Jour. Cancer, September, 1932.

[4] British Jour. Surg., 1932.

[5] Am. Jour. Cancer, September, 1932.

of the breast began in 1922 with some recurrent cases in which it was found that, with small amounts of radium in platinum needles with a wall thickness of 0.5 mm., it was possible to obtain one cure among seven patients. The others died within a comparatively short time from metastases in other parts of the body. If cures could be obtained in a recurrent growth, Keynes asked, why not also with a primary growth? In 1924 he treated such a primary tumor with the result that the patient is still alive, despite several series of local recurrences.

"A table is appended analyzing the results of the 171 cases, the tabulation of the results showing that in 9 with a Class I tumor, 78 per cent are alive at the end of three years; of those with Class II tumors, 36 per cent are alive at the end of three years, and of those with Class III tumors, which is the larger inoperable group, 46 per cent are alive at the end of three years. The latter result is most interesting, because these patients cannot be helped by surgery. In any case, the numbers are small, and the final re-survey must be made at the end of five years.

"The author concludes that in general the results of radium treatment compare favorably with those obtained by pure surgery. He does not claim that radium treatment should supplant surgery, however, but that it should have a definite place in the treatment of carcinoma of the breast, and should often be used instead of, or in combination with, surgery, according to the individual circumstances. For very advanced or inoperable tumors, radium is the treatment of choice. For the earliest and smallest tumors, radical operation is unnecessary. Excellent results can be obtained by radium alone, or radium combined with conservative surgery."

Here we have examples of two outstanding clinicians, one in Germany obtaining results with x-rays alone which compare favorably with the best surgical statistics, and one in England achieving the same by the use of radium. Would it not be logical, therefore, to assume that by an intelligent combination of both these agents, even better results might be anticipated? We believe it would, and we shall, therefore, enlarge briefly upon the subject.

X-ray, as we view it, is necessarily a type of on-the-surface treatment; that is, every application must reach its quest through some overlying skin or surface covering. Radium, on the other hand, is more serviceable when it can be placed in direct contact with, or into, the neoplastic area; hence its employment interstitially.

For a number of years it has been the custom of our own clinical group to apply our knowledge of the individual action of these two agents and use them accordingly in all our breast cancer work. Our technic has been described elsewhere[6] and will be omitted from the present discussion, except to state that with radium implantation it becomes necessary to group the patients according to type of lesion, size of breast, and degree of involvement. Very large, fatty, or pendulous breasts are not implanted unless tumor is localized and within reasonable limitations as to size. Otherwise such a breast is subjected to the routine sterilizing course of x-radiation and then removal by the electrotome, at which time the radium implantation is completed in the adjacent tissues and gland chains.

When any large quantities of x-rays are directed to a tumor through the lung-fields, we have always been apprehensive about fibrosis of the chest structures. Experience shows us, however, that this danger has been considerably overestimated as it occurs only in a comparatively limited number of patients, and then most usually in cases in which inflammatory processes have befogged the clinical picture. It is naturally advantageous to the patient, however, to avoid as much unnecessary radiation as possible; hence, we gladly availed ourselves of Dr. Holfelder's recent suggestion and cross-fired the breast areas by the so-called tangential method which was so well described by him. With care and a little ingenuity one can now irradiate a breast field from three or four angles and obtain a marked increase in the effective depth dose with x-radiation, bringing a definite benefit to the patient,

[6] The Management of Breast Cancer, Jour. Am. Med. Assn., March 5, 1932, XCVIII; Experiences in Interstitial Irradiation of Carcinoma of the Breast, Am. Jour. Roentgenol. and Rad. Ther., August, 1932, XXVIII; Management of Cancer of the Breast, Southwestern Med., December, 1932.

with a minimum of by-effect or untoward late sequelæ.

The immediate object in all cases is to employ sufficient radiation to destroy all malignant cells; otherwise our ultimate objective, as well as time and effort, would be lost. With this aim in mind, we began many years ago to plan the foundation of an effective treatment combination for carcinoma of the breast in which both x-rays and radium were to be employed in various experimental combinations, and we refer to the following historical outline as a reasonable justification for such action.

During the first decade of clinical x-ray experimentation (1896–1906), I held the opinion that surgery should almost always come first and that the x-rays should follow immediately, and be applied, if possible, to the open operative field. Only one local surgeon supported me at that time, so there was no opportunity afforded to carry on any extensive investigation. Two cases were, however, reported.[7] Later, my old respected and late lamented friend, Emil Beck, of Chicago, conceived the idea of making all breast surgery for cancer on the wide open plane, radiating the denuded area intensively after removal of the breast, and permitting the wound to heal slowly by granulation. The lesson taught by this experience unquestionably demonstrated the carcinolytic action of x-rays and verified the *rationale* of pre-operative radiation.

The second decade up to 1915–16 witnessed great improvement in x-ray apparatus, as well as many refinements in radium applicators. Methods for the measurement of wave lengths and dosimeters of varying types were offered to help standardize radiation therapy, which was assuming international importance as a medical specialty. It was during this period that I began seriously to advocate pre-operative x-radiation. Evidence was rapidly accumulating to show that one could not afford to go into the practice of clinical radiology unless willing to earnestly apply oneself in an attempt to learn the intricacies and master some of the angles of this rapidly growing and by no means simple science. Those who have been willing to spare the time, the money, and the effort in this endeavor are well satisfied with the results which have accrued. Many, however, have neglected to follow the path rigorously, and this accounts in no small degree for much of the adverse criticism to which the science of clinical radiology has been subjected. Nevertheless, during the following decade and down to the present time, the technic for treatment of cancerous disease by x-rays and radium has steadily advanced, and greatly improved results are now apparent, even in carcinoma of the breast.

About 1917, at the end of the second decade, there appeared upon the market radium element needles, made of iridium steel, which we began to utilize in some recurrent breast cancer nodes. These gave immediate results which were highly encouraging, but later we learned to our chagrin that the filter value of the needle covering did not prevent implantation necrosis, so we quickly discontinued their use. It was not until the end of the third decade (about 1927) that the platinum needle was substituted and we then resumed this type of radium service. Meanwhile, having become intensely interested in the possibilities of combined radiation as a major treatment for breast cancer, and having already acquired a not inconsiderable amount of experience, it appeared logical to assume that the earlier the x-ray or radium energy was directed in sufficient quantity to a cancer-bearing area, the more favorable would be the patient's outlook. We began more earnestly to study and apply this angle to our work, and subsequent events have assured us that it is bearing fruit.

Skepticism regarding the results claimed by radiologists always reverts to the fact that no convincing statistics are available which are prepared as accurately as the five-year records of pure surgery. This

[7] Plea for Combining the X-rays with Surgery in Mammary Carcinoma. Southern Calif. Practitioner, July, 1904.

	Name: Age	Year	Location	Classification (Steinthal)	Reactions and Notes as of Sept. 1, 1933	
1.	C., 68	1929	Left breast and axilla	S III	Breast—no palpable disease. Metastasis to right lung. Died in 1931.	Alive 2 years
2.	K., 63	1929	Left breast and axilla	S II	Breast—no palpable disease. Metastasis to spine. Died in 1932.	Alive 3 years
3.	B., 72	1930	Left breast and axilla	S II	Coronary thrombosis following operation on breast. Disease not controlled by radiation. Adenocarcinoma found in breast tissue. Died in 1932.	Alive 2 years
4.	B., 46	1930	Left breast and axilla	S II	Fibrosis of treated area. No palpable disease. Living in 1933.	Alive 3 years
5.	D., 49	1930	Right breast	S III	No palpable disease. Living in 1933.	Alive 3 years
6.	H., 55	1930	Right breast	S II	No palpable disease. Living in 1933.	Alive 3 years
7.	B., 51	1930	Right breast and axilla	S II	Breast removed and found to be the seat of a carcinoma. This was an unusually large breast. Living in 1933.	Alive 3 years
8.	McN., 39	1930	Right breast and axilla	S III	Disease still present in breast. Died of paroxysmal tachycardia in 1930.	Alive 4 mos.
9.	E., 43	1930	Left breast, axilla, and supraclavicular area	S III	Nodular palpable mass still present in breast. Axilla and supraclavicular areas normal. Living in 1933.	Alive 3 years
10.	N., 65	1930	Right breast	S I	No disease. Living in 1933.	Alive 3 years
11.	E., 62	1930	Right breast	S I	No disease. Section before implantation showed adenocarcinoma. Living in 1933.	Alive $2^1/_2$ years
12.	T., 54	1930	Right breast	S I	Breast normal. Living in 1933.	Alive $2^1/_2$ years
13.	K., 44	1931	Left breast, axilla, and supraclavicular area	S III	Breast normal. Some neuritis in arm. Axilla and supraclavicular areas normal. Living in 1933.	Alive 2 years
14.	C., 70	1931	Right breast	S II	No disease palpable, but breast deformed by former disease. Living in 1933.	Alive 2 years
15.	E., 60	1931	Left breast	S I	Breast normal. Living in 1933.	Alive 2 years
16.	W., 47	1931	Right breast and axilla	S II	Breast normal. Axilla negative. Living in 1933.	Alive 2 years
17.	S., 77	1931	Left breast and axilla	S II	Mass still palpable. Axilla—no disease. Living in 1933.	Alive 2 years
18.	D., 70	1931	Left breast and axilla	S II	Breast normal. Biopsy showed squamous-cell carcinoma. Axilla normal. Living in 1933.	Alive 2 years
19.	R., 65	1931	Left breast and axilla	S II	Breast normal. Biopsy showed adenocarcinoma. Axilla—no palpable disease. Living in 1933.	Alive 2 years
20.	W., 54	1931	Left breast and axilla	S III	Metastasis to liver. Breast normal except for deformity. Died in 1932.	Alive 1 year
21.	R., 51	1931	Right breast and axilla	S IV	Metastasis to brain. Biopsy showed adenocarcinoma. Breast negative. Node palpable in axilla. Died in 1932.	Alive 6 mos.
22.	T., 45	1931	Left breast and axilla	S II	Lost trace of patient.	
23.	W., 47	1931	Right breast	S I	Breast normal. Living in 1933.	Alive 2 years
24.	J., 46	1932	Right breast	S I	Breast normal. Living in 1933.	Alive 1 year
25.	H., 61	1932	Right breast	S I	Breast normal. Living in 1933.	Alive 1 year

	Name: Age	Year	Location	Classification (Steinthal)	Reactions and Notes as of Sept. 1, 1933	
26.	B., 70	1932	Left breast	S I	Developed node which was needled later. Breast and axilla—no palpable disease at present. Living in 1933.	Alive $1^1/_2$ years
27.	M., 64	1932	Right breast	S III	Breast almost normal, except adherent scars to ribs. Living in 1933.	Alive 1 year
28.	W., 52	1932	Left breast and axilla	S II	Small palpable mass in breast yet. Axilla normal. Living in 1933.	Alive 1 year
29.	F., 60	1932	Left breast	S I	Breast normal. Living in 1933.	Alive 1 year
30.	C., 72	1932	Left breast and axilla	S II	Massive recurrence. Biopsy showed adenocarcinoma. Died in 1932.	Alive 6 mos.
31.	R., 72	1932	Left breast and axilla	S III	Rapid extension of disease. Died in 1932.	Alive 4 mos.
32.	W., 52	1932	Right breast and axilla	S II	Breast normal. Living in 1933.	Alive 1 year
33.	S., 65	1932	Right breast, axilla, and both supraclavicular areas	S III	Has metastasis to spine. Axilla normal and supraclavicular areas normal. Living in 1933.	Alive 1 year
34.	L., 59	1932	Right breast	S I	Breast feels normal, but nipple somewhat firm—may need more treatment. Living in 1933.	Alive 1 year
35.	S., 62	1932	Left breast and axilla	S II	Small, firm nodule still present. Axilla normal. Living in 1933.	Alive 1 year
36.	B., 73	1932	Right breast and axilla	S II	Breast normal. Axilla—no disease. Living in 1933.	Alive 6 mos.
37.	R., 46	1932	Left breast and axilla	S II	Breast and axilla—no palpable disease. Living in 1933.	Alive 6 mos.
38.	V., 65	1932	Right breast and axilla	S III	Temporary improvement. Massive recurrence. Biopsy showed adenocarcinoma. Died in 1933.	Alive 4 mos.
39.	P., 42	1932	Right breast	S I	Breast normal. Living in 1933.	Alive 6 mos.
40.	M., 65	1932	Right breast, axilla, and supraclavicular area	S III	Still has node in supraclavicular area but breast apparently normal. Living in 1933.	Alive 6 mos.
41.	A., 51	1932	Left breast and axilla	S II	Breast feels normal. Axilla shows no palpable disease. Living in 1933.	Alive 6 mos.

SUMMARY OF ALL CASES TREATED

1.	Living 6 months to 3 years free from cancer	31
2.	Lost trace of patient	1
3.	Died of cancer	6
4.	Died of intercurrent disease	3
	Total	41

is quite true, for radiological technic has developed so rapidly and changed so radically that no five-year statistical records of value have been compiled: those which have accompanied surgical statistics are misleading and quite unfair to radiology. Nevertheless, we are convinced that radiation has materially added to the five-year clinical cures in carcinoma of the breast, and if we are to believe the evidence which has accumulated during the past three or four years, we must agree with Keynes and Wintz that radiation alone is superior to pure surgery; in fact, our own experience with short wave x-rays and interstitial gamma radiation has shown this in no uncertain manner.

In conclusion, I beg to submit a pre-

liminary chart of reactions under our new technic, not as a statistical report, but as one sufficiently encouraging to warrant a continuation of this study and effort. This report does not include patients irradiated since January 15 of the present year [1933], nor patients upon whom electrosurgical methods have been employed.

I desire to acknowledge the faithful work of my radiological associate, Dr. William E. Costolow, and my surgical associate, Dr. O. N. Meland, without whose continued co-operation my own limited efforts would have been futile.

1407 S. Hope St.

THE *RATIONALE* OF X-RAY TREATMENT IN ENCEPHALITIS LETHARGICA[1]

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THE essential lesion in encephalitis lethargica and in poliomyelitis is a perivascular mantling by small round cells. It occurred to the senior author that the symptoms are largely due either to pressure or to circulatory disturbance produced by the perivascular lymphocytic infiltration. Since these cells are highly sensitive to irradiation, it was thought that x-radiation in minute doses should be the logical treatment in these conditions. This is the first opportunity that has presented itself to determine the efficacy of such treatment. The results obtained are so striking that we deem it worth while to report them.

CASE REPORTS

Case 1. D. T., a white girl, aged 17 years, admitted to the Presbyterian Hospital on Jan. 26, 1934, suffering with headache, drowsiness, nausea, and nasal discharge. She had had a chronic discharging ear since infancy. In childhood she had had measles, whooping cough, chicken pox, and frequent colds associated with persistent bronchial coughs. In July, 1931, she was treated for general pansinusitis.

The present illness began suddenly on Jan. 24, 1934, with headache in the morning, followed by a semicomatose condition in the afternoon. She vomited, had a profuse muco-purulent nasal discharge, and a slight facial paralysis.

On admission to the hospital, the physical examination revealed an extremely drowsy patient, with tinnitus, slight internal strabismus, slight left facial paralysis, negative visual fields and fundi, temperature 99.6° F., pulse 78, respirations 20. The following day a lumbar puncture was performed, about 4 c.c. of clear, colorless fluid being removed under normal tension. The cell count was 10 per cubic millimeter, all lymphocytes. The globulin was not increased, the sugar content was normal, micro-organisms were not seen nor was there any growth in the culture. Roentgenograms of the sinuses showed very marked cloudiness of both antra, anterior and posterior ethmoids, and sphenoid sinuses. The urinalysis was negative. The patient continued to have severe headache, occasional projectile vomiting, purulent nasal discharge, a productive cough, anorexia, and developed a persistent rigidity of the neck. The second day after admission, under local anesthesia, large polypoid masses of granulation tissue were removed from both nostrils to facilitate drainage. The following day a second lumbar puncture showed slightly cloudy fluid under normal tension. The cell count was 375 per c.mm., consisting of a few erythrocytes, lymphocytes 75 per cent, neutrophils 21 per cent, endothelial cells 4 per cent. Acid-fast or other micro-organisms were not seen. The culture showed no growth. Then both frontal sinuses, the right ethmoid and sphenoid sinuses, which were filled with granulations and pus, were opened and drained but not curetted. The culture of the pus showed a growth of short chain streptococci. The fourth day after admission her condition remained unchanged. She became very restless, had to be restrained from trying to get out of bed, cried out occasionally, vomited four times, took fluids scantily, and was still drowsy.

On January 31, in addition to the former symptoms, for the first time she showed definite weakness of the left arm and leg. She was semicomatose but could be roused. A lumbar puncture was done but no fluid was obtained. On February 1 she had projectile vomiting, screamed fre-

[1] Accepted for publication April 12, 1934.

quently, was very restless for short periods, slept the rest of the time and complained of frontal head pains. Hypodermoclyses were frequently given. On February 2 a fourth lumbar puncture showed clear, colorless fluid under normal tension. The cell count was 62 per c.mm., including an occasional erythrocyte, lymphocytes 99 per cent, neutrophils 1 per cent. Microorganisms were not seen. During the next four days there was no particular change in her condition. During the course of her illness she ran a low grade temperature ranging between 98.6° and 100° F. On February 7, x-ray therapy was first applied. Following it she was irrational, had to be restrained, screamed, and did not appear to be alert mentally. This was considered as being a possible reaction from the irradiation. The next day she held a cup with her left hand for the first time since her illness began, and generally showed marked improvement. X-ray treatments were given on February 7 and February 10. A lumbar puncture on February 13 showed clear, colorless fluid under normal tension, with 12 cells per c.mm., all lymphocytes. Globulin was not increased; sugar was normal. She was discharged on February 14, symptom-free. Three more x-ray treatments at intervals of 72 hours were given at the office. Spinal puncture on April 5 showed clear, colorless fluid under normal tension with 2 cells per c.mm., globulin not increased, sugar content normal. She is apparently as bright mentally as she was prior to this illness.

Case 2. T. M., a white male, age 53, was admitted to the Presbyterian Hospital on March 15, 1934, with symptoms of psychosis of two weeks' duration. Prior to admission he had been under observation in another institution. There his condition became progressively worse until it appeared hopeless and his family considered having him admitted to a psychopathic institute. Examination of the spinal fluid then showed clear, colorless fluid, under normal tension, containing 60 cells per c.mm., including lymphocytes, polymorphonuclears, mononuclears; slightly increased globulin, normal sugar content, and negative Wassermann reaction. Urinalysis showed the presence of a trace of albumin and a moderate number of leukocytes. Physical examination showed cardiac arhythmia, normal reflexes, negative visual fields and fundi. A diagnosis of cardio-nephritis was made.

On admission to this hospital he could only mutter in an unintelligible whisper. He showed neck rigidity, restlessness, drowsiness, and disorientation. A lumbar puncture showed clear, colorless fluid, under normal tension, containing 9 cells per c.mm., all of which were lymphocytes. The globulin was not increased and the sugar content was normal. The blood urea was 20 mgm. per 100 cubic centimeters. The blood Wassermann and Kahn tests were negative. A diagnosis of encephalitis associated with a cardiovascular condition was made. The next morning the first x-ray treatment was given. The following afternoon the patient showed slight improvement, being able to talk a little more distinctly. A second x-ray treatment was given 72 hours after the first. The following day the patient showed marked improvement. When the attending physician entered, the patient exclaimed: "Meet Thomas M. I haven't been Thomas M. for a long time, but now I am, the same as I was before my illness." His general condition bore out this statement. Two more x-ray treatments were given, 48 hours apart, after which the patient was discharged, apparently free from any mental symptoms. The blood count before admission showed leukocytes 17,200, neutrophils 78 per cent, lymphocytes 14 per cent, monocytes 6 per cent. During the treatment the number of leukocytes fell from 15,500 to 12,300, and the polymorphonuclears fell from 69 to 58 per cent, while the lymphocytes rose from 21 to 30 per cent. The patient's temperature tended toward subnormal, ranging between 96.6° and 99.6° F. The x-ray dosage was the same as that used in the first case. At the present writing the

patient is mentally alert and resuming his former duties.

Case 3. N. L., a white male, age 25, was admitted to the Presbyterian Hospital at 7:30 P.M., March 16, 1934, in a semicomatose condition. The onset of the present illness began suddenly in the morning, with a severe frontal headache. Physical examination on admission revealed a drowsy, restless patient, with opisthotonos, and no abnormal reflexes. A lumbar puncture showed bloody fluid, under marked tension, with normal sugar content and negative culture. The smear appeared like a blood smear. The next day the condition of the patient was worse. His headache continued and he vomited occasionally. Examination showed unequal pupils, rotary nystagmus, normal visual fields and fundi, bilateral Kernig's sign, exaggerated knee jerks, and marked ankle clonus. The spinal fluid appeared similar to that of the day before. X-ray examination showed marked cloudiness of the ethmoid and sphenoid sinuses. A cisterna puncture in the evening also showed bloody fluid. The blood count was 10,400 leukocytes, polymorphonuclears 87 per cent, and lymphocytes 13 per cent. The urinalysis was negative. Therefore, a presumptive diagnosis of subarachnoid hemorrhage was made. Hypertonic glucose was administered intravenously and magnesium sulphate by mouth, to relieve intracranial pressure. For three days the condition of the patient remained unchanged and the headache, restlessness, and drowsiness continued. On March 20 a cisterna puncture showed the spinal fluid under marked tension, containing considerably less blood than at the time of the previous examination. On March 26 the patient vomited, was irrational, showed rigidity of the neck, a Babinski on the right side, absent lower abdominal reflexes, dilated pupils, and normal fundi. A cisterna puncture showed slightly cloudy fluid, under normal tension, with normal sugar content, 65 cells per c.mm., lymphocytes 94 per cent, neutrophils 4 per cent, endothelials 2 per cent, many erythrocytes. Micro-organisms were not seen in the smear or culture and the Wassermann reaction was negative. March 27 the patient continued to have headache, was drowsy and incontinent, and vomited. March 28 the blood count showed 7,300 leukocytes, polymorphonuclears 49 per cent, lymphocytes 37 per cent, eosinophils 7 per cent, and monocytes 7 per cent. For the first nine days the temperature ranged between 100° and 102° F. March 31 a spinal puncture showed very slightly xanthochromatic fluid, under moderately increased tension, with normal sugar content, 93 cells per c.mm., of which 97 per cent were lymphocytes, 1 per cent neutrophils, and 2 per cent endothelial cells. A diagnosis of encephalitis was made because of the increased number of lymphocytes in the spinal fluid, and an x-ray treatment was given. The dosage was small, being the same as that given in the two previous cases. Eighteen hours later the patient was markedly improved; the next day he appeared well, could talk rationally, and had no headache. A second x-ray treatment was given 48 hours after the first. A spinal puncture the following morning showed clear, colorless fluid, under normal pressure. There were 74 cells per c.mm., 98 per cent lymphocytes, 2 per cent endothelial cells, normal sugar content, and slight increase in globulin.

COMMENT

The diagnosis of encephalitis lethargica is based upon objective symptoms of drowsiness, deranged mentality, and signs referable to lesions in the basal nuclei. When, in such a case, the clear spinal fluid shows an increased number of lymphocytes, increased or normal globulin content, and normal sugar content the diagnosis of encephalitis lethargica is established. It is differentiated from meningismus produced by toxic irritation, by the cytologic findings in the spinal fluid. In meningismus the cell content of the fluid remains normal.

In the first case, because of the presence of a pansinusitis the question of a brain abscess or of a toxic affection of the brain was considered. The cytologic findings of the spinal fluid, however, established the diagnosis of encephalitis. The first x-ray treatment brought about a phenomenal improvement. The cell count of the spinal fluid was also promptly reduced. After several subsequent small doses of x-ray had been administered, the symptoms entirely disappeared. The second case, on account of the predominant mental derangement, was prognosticated as hopeless in one institution. We felt that the increased number of lymphocytes in the spinal fluid warranted the diagnosis of encephalitis lethargica, and, therefore, x-ray therapy was instituted. The results were most gratifying.

In the third case, at the onset there was a spontaneous subarachnoid hemorrhage and symptoms referable to it. At first the possibility of meningitis was considered and antimeningococcic serum was given, but the leukocyte count of 10,400 made this diagnosis improbable. Because of the blood present, the cytology of the spinal fluid could not be determined. As the hemorrhage stopped, the condition of the patient appeared similar to that of the previous cases, that is, restless, drowsy, with severe headache and vomiting. The spinal fluid took on the nature of that found in encephalitis lethargica, *i.e.*, an increased number of lymphocytes. The number of cells was increasing prior to irradiation and did not fall as rapidly after two applications as in the other cases. This fact, coupled with the initial subarachnoid hemorrhage, suggests a greater virulence. The patient is still under treatment and will require a more extended application of the method.[2]

The matter of roentgen dosage was a problem, inasmuch as we were unaware that there had been any previous experience in the treatment of encephalitis by radiation.

Realizing the marked radiosensitivity of lymphoid tissues and lymphocytes and having noted toxic reactions when these tissues were radiated even moderately, we aimed by small doses to produce salutary effects and avoid any severe reaction which might retard recovery and discredit the method.

The first treatment was, therefore, given as follows: 135 K.V., 5 ma., distance 15 inches, filters 4 mm. aluminum, time 2 minutes, mechanical single disc rectification. The erythema time had never been computed by a physicist for this apparatus but on a similar one it had been found to be approximately 30 minutes. The estimated dose in r units was, therefore, approximately 40, or one-fifteenth of a skin erythema dose.

Even this minute dose in the first case caused a brief upset the ensuing night, with hallucinations, but the improvement noted on the following day warranted a continuance of the experiment. For economic reasons it was desirable to abbreviate the hospitalization; therefore, another dose was administered 48 hours after the first. The second dose was given with the same technic, adding one minute, *viz.*, three minutes, or 60 r. The third dose was again increased by one minute, to 80 r, and after a 48-hour interval. The clinical improvement has already been described in this paper. The day following the third treatment the patient was removed to her home and the radiation continued at the office, where three more doses were applied. The time was increased to five minutes, or 100 r for the fourth and succeeding doses, and the intervals lengthened to 72 hours. After the sixth application there seemed to be no reason for continuing the treatment. The areas radiated were the lateral aspects of the skull, alternating sides, only one side being treated on any one day.

Paradoxical as it may seem and in contravention of the usual concept that heavy roentgen dosage is essential in the treat-

[2] This patient has been symptom-free since leaving the hospital. Irradiation was given weekly till May 10, 1934. His spinal fluid on May 1 contained 14 lymphocytes per c.mm. He is now working.

ment of other conditions, in this disease only minute doses are necessary. It is recommended that caution be observed to prevent too rapid destruction of lymphocytes, the development of toxemia, and the possibility of harmful immediate effects which would tend to discredit the method and prevent its more general application.

Because of the similarity of the lesions in poliomyelitis and Landry's paralysis, this treatment should result in beneficial effects in these conditions. We think that the dosage should similarly be very small at first and the areas to which it should be applied would depend upon the regions involved.

In the three cases reported herein this method of treatment certainly shortened the duration of the illness and the period of hospitalization. Because of the removal of the pressure before permanent damage was done to the nerve cells, the treatment certainly obviated the devastating post-encephalitic effects.

We are now attempting to treat cases with a post-encephalitic syndrome of long duration. While we do not expect any beneficial results, on account of permanent damage already done, we feel this treatment should be given a trial.

It has been predicted by others that the ultimate value of radiation may not be in the treatment of malignancy but in the cure of many acute or subacute diseases. It is hoped that we have added another to the slowly growing number of lesions responding to radiation.

SUMMARY

1. A new application of roentgen therapy has been tried for the relief of pressure or circulatory disturbance in the central nervous system produced by perivascular lymphocytic infiltration.

2. Rapid absorption of these lymphocytes by radiation has resulted in an immediate alleviation of the symptoms in three cases of encephalitis lethargica.

3. Since the lesions in poliomyelitis and in Landry's paralysis are similar to those of encephalitis, it is suggested that this treatment should be beneficial.

4. The dosage should be very minute since lymphocytes are extremely sensitive to radiation and large doses would produce too rapid absorption of these cells.

WHERE IS THE DIAPHRAGM?[1]

By WILLIAM H. STEWART, M.D., and H. EARL ILLICK, M.D., *New York City*

IN the normal chest the position of the diaphragm is well known and its shadow and mobility are characteristic, but in many disease processes of both thorax and abdomen the diaphragm may be so altered, either temporarily or permanently, that its exact location may be difficult to state. As a matter of medical diagnostic interest and especially if operative measures are deemed necessary, the localization of the diaphragm may become of great importance to the surgeon. This paper comments on some of the roentgenographic findings in diseases of the chest and abdomen in which the position of the diaphragm may be uncertain, and discusses the problem of exact localization by the roentgen ray.

The diaphragm by virtue of its median position between chest and abdomen is of interest to the roentgenologist, not so much because of its intrinsic disease processes as because of its abnormalities, in cases in which there is pathologic involvement of thoracic or abdominal viscera. Abnormal variations in the position, the contour, or the extent of the excursion of the diaphragm may direct attention to a lesion of abdominal or thoracic organs.

The *anatomy* of the diaphragm is well known, as well as its normal roentgen appearance. It is a complete septum between thorax and abdomen only in mammals. Above the diaphragm and in contact with its superior surface, are the lungs, heart, esophagus, and aorta; below it, and in contact with its inferior surface, are the liver, stomach, and spleen. By virtue of its intimate relation with these organs, intrinsic disease of the diaphragm or of any one of these viscera soon results in characteristic roentgen manifestations which call attention to and aid in the detection of the disease process.

The diaphragm is pierced by three openings—for the aorta, the esophagus, and the vena cava. The central portion of the diaphragm is composed of fibrous tissue; the outer margin is muscular. The dome is usually regular and made up of one smooth curve; at times it may present several smaller, shorter curves. There is considerable individual variation in the degree of excursion—from one-half inch on quiet breathing to two inches or more on deep respiration, males more than females. Both sides possess equal mobility. There is variation in the shape and position, accounted for by the habitus. A short, stocky person has a high position and a gentle curve of the dome, while a long, thin individual has a low position and a sharper curve. The left side of the diaphragm may be elevated by "gas" in the stomach or splenic flexure. Normally the right side of the diaphragm is higher than the left.

Roentgen technic takes into account these anatomic considerations and strives to demonstrate the character of the variations and abnormalities concerned with the position, contour, and excursion of the pathologic diaphragm.

ROENTGENOGRAPHIC AIDS AND TECHNIC

Pneumothorax is a simple aid, not used frequently enough when there is a question concerning the exact location of the diaphragm and certain tumors which may be readily outlined by the injection of air into the pleural cavity (Fig. 1). In some cases fluid is present, which is first withdrawn, after which air is introduced in as large quantity as possible. Cases with pleural fluid are tolerant to injection of large quantities of air without distress. The resulting hydropneumothorax permits positioning of the patient so that tumor masses and the diaphragm are accurately

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

demonstrated. Such a method is valuable in many cases with thoracic metastases, a primary tumor, pleural malignancy, mediastinal involvement, and to differentiate certain right upper quadrant abdominal lesions.

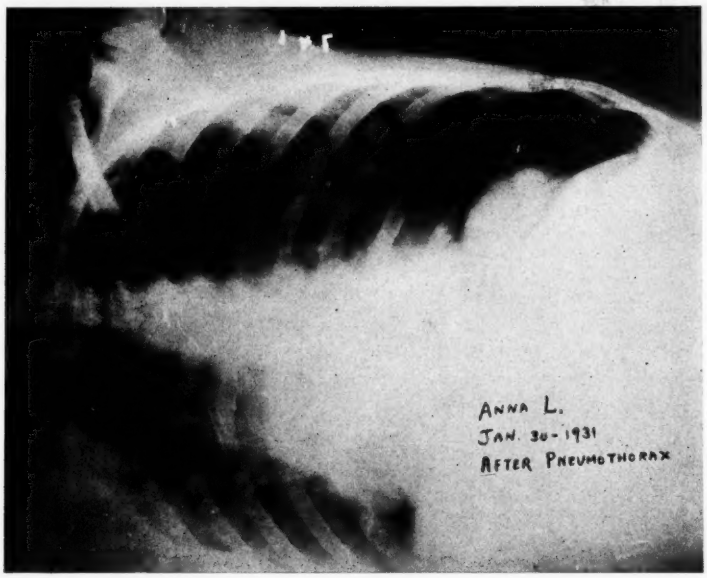

Fig. 1. Pneumothorax successfully outlines a tumor of the superior diaphragmatic surface. Operation and biopsy demonstrated a lipoma.

Bronchography.—This procedure has been so simplified of late that it lends itself to the outlining of the bases of the lungs as a means, at times, of demonstrating the position of the diaphragm (Fig. 2). A little cocaine solution sprayed into the posterior pharynx permits dropping of warm opaque oil into the trachea, thus outlining the bronchi. The procedure may easily be performed at the bedside.

Respiratory Excursion.—Some patients will be too sick to be transported to the laboratory; in such cases, bedside examination may be used to recognize the diaphragm and the limits of its excursion. Two chest exposures are made on one film—at the height of inspiration and a second one at the end of complete expiration; a double image results, with a gap between the elevated and descended limits of the diaphragm during respiration. The difference between the two sides or a

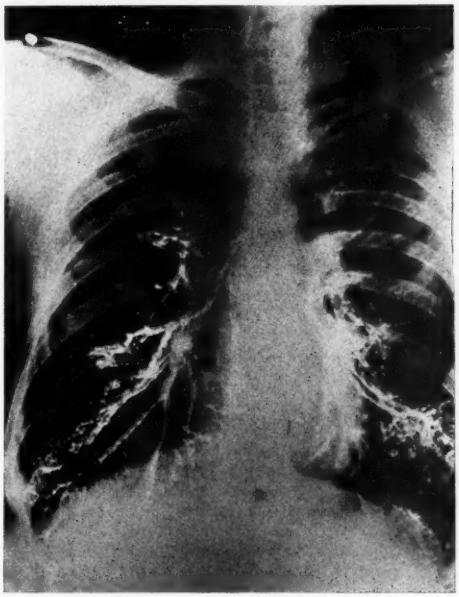

Fig. 2. Illustrating how a bronchogram may aid in localizing the diaphragm, especially in pulmonary lesions. The technic of bronchography has been standardized of late until it should now have more routine use in obscure cases.

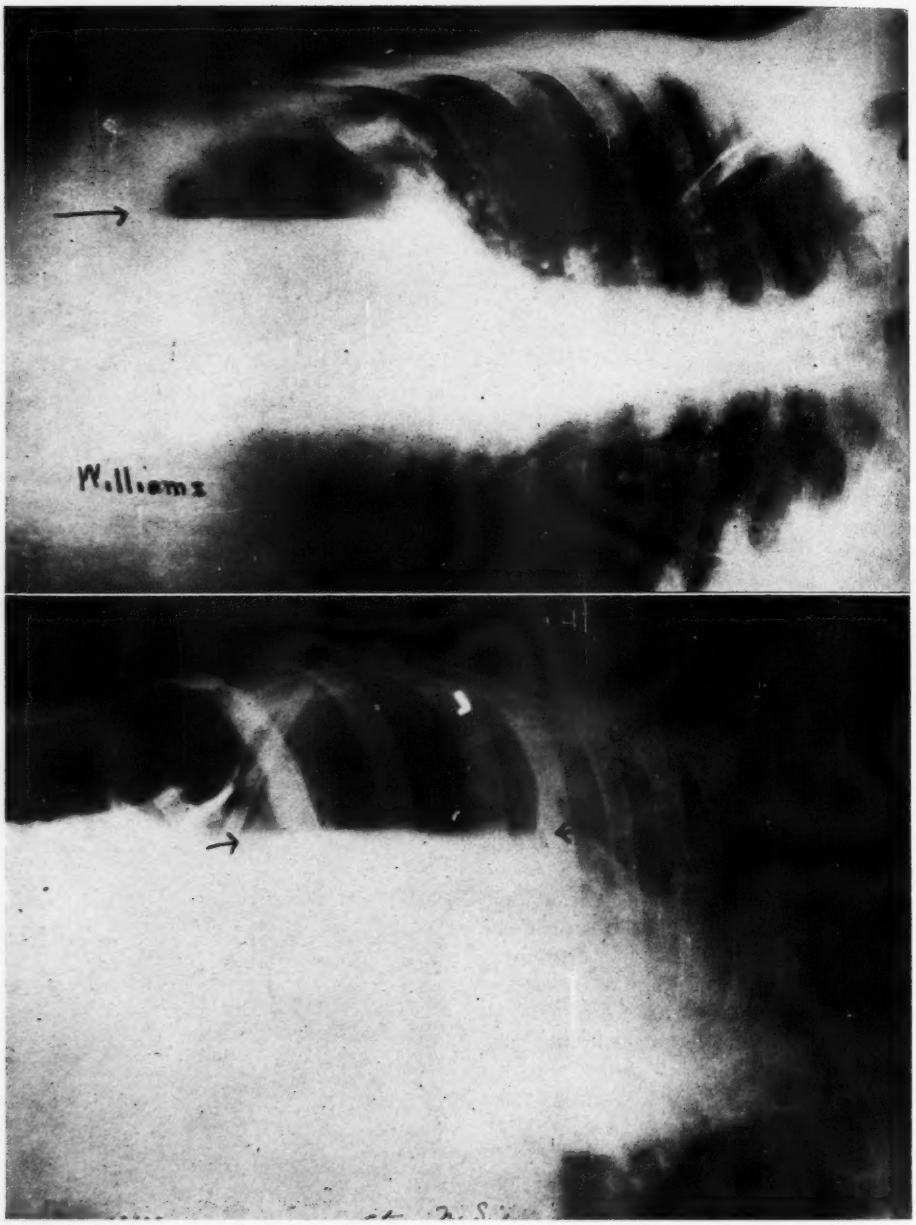

Fig. 3 (*above*). Air above a fluid level on the left side of the body.
Where is the diaphragm?
Was a large lung abscess, bronchoscopy demonstrating pus coming from the left, lower main bronchus.

Fig. 4 (*below*). Air above fluid levels on the left side of the body. The lower fluid level (indicated by arrows) is in the stomach, distinguishable by fluoroscopy after barium had been given orally. The upper fluid level is in an encapsulated empyema, the diaphragm being localized fluoroscopically between the two.

one-sided limitation of excursion can be made a matter of permanent record in this manner for comparison at subsequent examinations.

Fig. 5. An example of localization of the diaphragms by pneumoperitoneum, gas outlining the inferior diaphragmatic surface.

LATERAL AND DIRECT EXAMINATIONS

Roentgenographic examinations made with the patient in the horizontal position, affected side uppermost, film anterior or posterior, with the x-ray tube opposite, are effectual in demonstrating abscess cavities, with or without fluid level, and in locating the diaphragm (Figs. 3 and 4) in patients who are too sick to stand up or otherwise co-operate in obtaining the usual roentgenographic information. A true lateral with the affected side against the film, preferably with the patient erect, will localize the diaphragm in many instances. Pleural adhesions, effusion, and pulmonary consolidations are differentiated by this means. Diaphragmatic detail can often be obtained by using a Bucky diaphragm, with the film rather dense. Also, in effusions the concave curve is more clearly demonstrated and the detail of the base of an involved lung, when hyperaërated, is best obtained with a Bucky film.

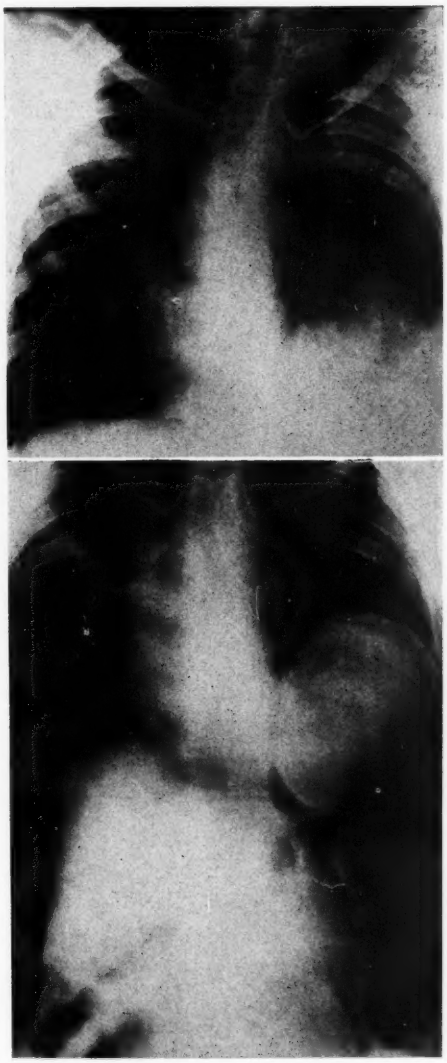

Fig. 6-*A* (*above*). A rounded, dome-like, smooth, superior border at the base of the right chest, believed to be the left side of the diaphragm. Pulmonary fields clear. Subdiaphragmatic tumor is to be ruled out.

Fig. 6-*B* (*below*). Pneumoperitoneum localizes the diaphragm. Case was one of huge tuberculous cyst resting on the diaphragm.

PNEUMOPERITONEUM

Attacking the problem from below the diaphragm we at once recognize the value of pneumoperitoneum. One of us long ago called attention to the ability of the roentgenologist to demonstrate the subdia-

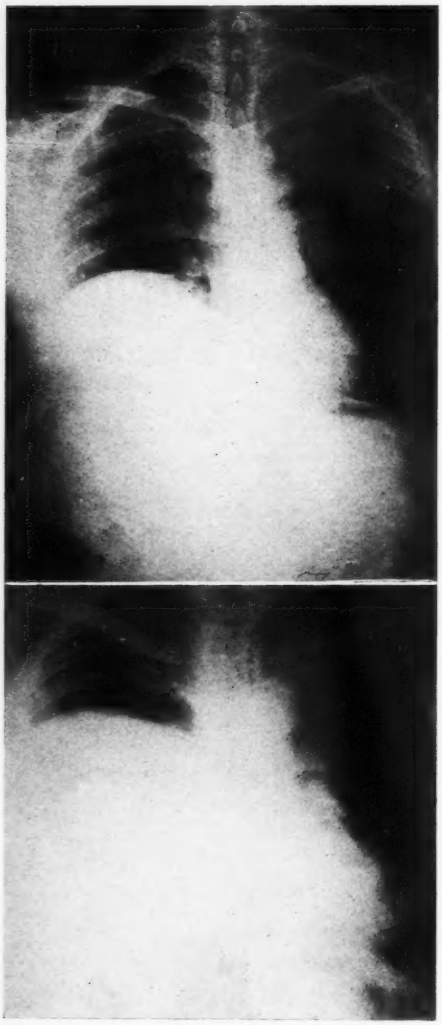

Fig. 7-*A* (*above*). Rounded, superior border resembling dome of diaphragm at the right base. Marked limitation of motion.

Fig. 7-*B* (*below*). This patient had progressive elevation of the shadow resembling the dome of the diaphragm, combined with a clinical history of pain, coughing, and increasing dyspnea. At operation a large lymphosarcoma was found *above* the diaphragm, with a rounded upper border accompanied by enlarged mediastinal glands.

phragmatic space (Figs. 5, 6-*A*, and 6-*B*). Of late years the presence of air or gas under the diaphragm in perforated gastric and duodenal ulcers has shown excellent diaphragmatic localization.

We have been advocating for some time the introduction of a small quantity of oxygen or carbon dioxide into the peritoneal cavity in an endeavor to differentiate the upper liver border from the diaphragm. Only a small quantity of the gas is used and the patient does not suffer from the discomfort of distention. The method may be used at the bedside, the patient not being transported at all, since a bedside x-ray unit suffices to give us roentgenograms for localizing the diaphragm with certainty and demonstrating its exact position. This procedure has limited usefulness in acute or subacute inflammatory lesions as it requires the patient to be placed in an erect position, either sitting or standing.

INTRODUCING AIR OR GAS INTO THE STOMACH

The left diaphragm can be localized by the intestinal gas in the stomach, which may be purposely increased by a Seidlitz powder or with an air pump through a stomach tube. In cases in which a fluid level is present on the left side in the region of the diaphragm, barium must be given to differentiate stomach contents. This may seem an uncalled-for suggestion, but we have seen cases in which it was necessary to differentiate the stomach with its fluid contents from a large abscess of the lung in the extreme lower portion of the lower lobe of the left lung. It is of value also in diaphragmatic hernias and eventration, which as a rule occur on the left side.

THOROTRAST

Recently thorotrast has been used to better demonstrate the size, shape, position, and changes in the structure of the liver and spleen, thus frequently indirectly locating the diaphragm from below. The authors feel, however, that its use is inadvisable until every other means has been exhausted.

Finally, with all the skill that the roentgenologist can use there will be an occasional case in which the location of the

diaphragm will be exceedingly difficult or even impossible: mostly impossible on account of the acute illness of the patient or because the surgeon cannot give the roentgenologist time enough to work out the problem as it should be done without jeopardizing the life of the patient. After all, this has to be thought of as well as the diagnostic procedure. Progressive elevation of what is supposedly the right diaphragm, combined with a history of pain, coughing, and increasing dyspnea, usually indicates a pulmonary lesion (Figs. 7-*A* and 7-*B*). Subdiaphragmatic pathology, such as abscess or hepatic suppurations, seldom elevates the diaphragm sufficiently to be mistaken for a lesion within the chest, and the history is not one of a chest disease.

The authors cannot close without a word of warning to those men who attempt to make a diagnosis without using all the data available—this means clinical, laboratory, and x-ray findings. The history is always most valuable in the differentiation.

THE INFLUENCE OF ROENTGEN RAYS ON THE GROWTH AND PHOSPHATASE ACTIVITY OF BONE[1]

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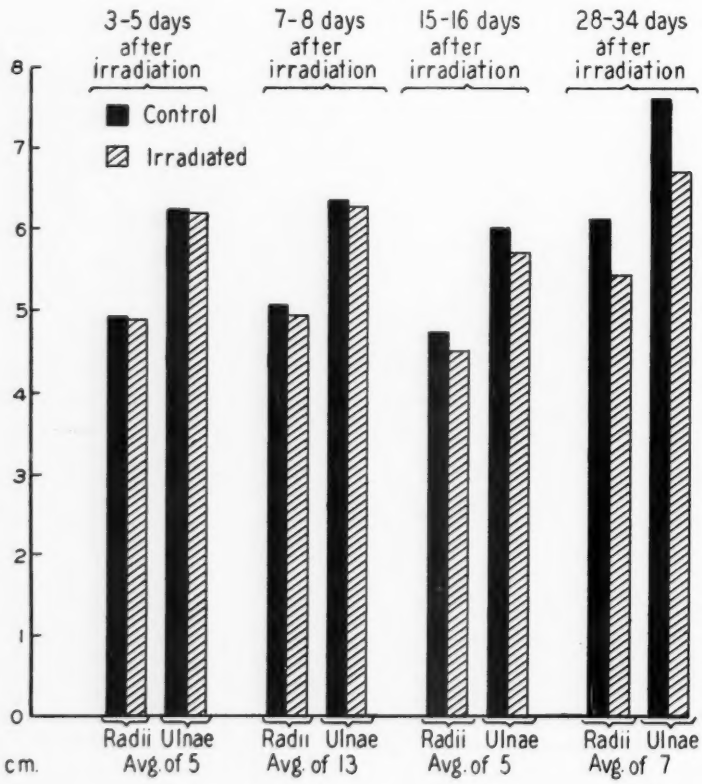
SHORTLY after the discovery of the roentgen ray, it was found that exposure of growing bone to this ray is followed by a period of inhibited growth. Brooks and Hillstrom (1) have recently made a study of the amount of irradiation necessary to inhibit growth, the quantity of the effect produced, the duration of the influence, and the coincident histologic changes.

In view of the significance attached by Robison (3, 4, 5) and other workers to the rôle of phosphatase in bone growth, it appeared to us that a simultaneous study of the effect of roentgen rays on growth and on phosphatase activity would be of

FIGURE I

LENGTHS



[1] Part of the expense of this investigation was borne by the Fluid Research Fund.

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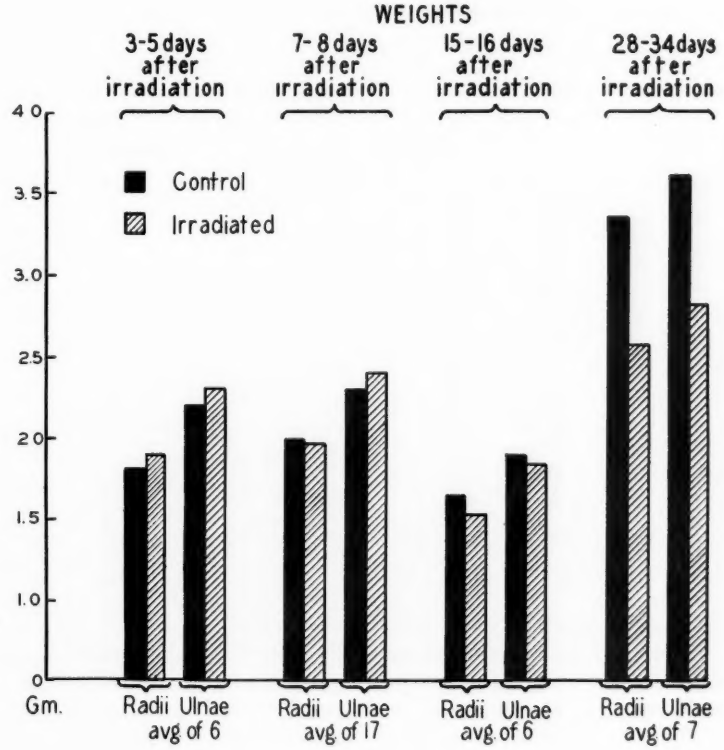
interest. The results of such a study are given in this paper.

PROCEDURE

Pups from 30 to 40 days of age, were exposed to approximately 600 roentgens over the left fore leg, the remainder of the animal's body being carefully protected with sheet lead. The factors constituting this dose were from 190 to 200 kilovolts, 20 milliamperes, target-skin distance of 55 centimeters, filter of 0.5 mm. copper and 1 mm. aluminum, and exposure of 20 minutes. The animals were sacrificed at intervals of from three to 34 days after irradiation, the bones from the right fore legs being used as controls. The bones of both fore legs were removed, and all soft tissue, including ligaments and periosteum, was carefully dissected away since accurate weight measurements were necessary. All bones were treated in as nearly uniform a manner as possible, and were then weighed in suitable weighing bottles on an analytical balance. Care was taken to avoid loss of weight by evaporation.

FIGURE II

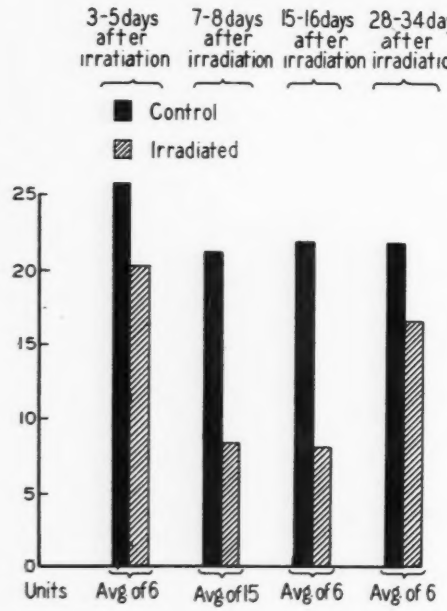


The length, including the epiphyses, was measured with a vernier caliper; the entire bone was then cut into small bits and ground in a mortar with No. 40 carborundum. This mixture was transferred to an Erlenmeyer flask of suitable size and 25 cc. of distilled water added for each gram of bone, the water being used in small portions to thoroughly remove the traces of material adhering to mortar, pestle, and spatula. A few drops of chloroform were

added, the flask stoppered, well shaken, and set aside at room temperature for a period of 72 hours, with occasional shaking. At the end of this period, the mixture was filtered through No. 40 Whatman

FIGURE III

PHOSPHATASE ACTIVITY OF RADII



filter paper. Determinations of phosphatase activity were made on this filtrate, using a technic similar to that described by Jenner and Kay (2) for plasma phosphatase.

In these experiments, 41 animals were used. The ulnæ were used for microscopic section of the line of growth at the epiphysis. However, values for weight and length of the ulnæ were obtained and are included in the averages given in Figures I and II. The microscopic findings will be reported in a separate paper. Thus all of the data on phosphatase represent values for the radii.

Figure I shows the effect of irradiation on the length of the exposed bones as compared with the controls. Appreciable differences were consistently found after from 15 to 34 days. Differences in length are not sufficient criteria for the estimation of growth, and we feel that differences in weight are also significant. The average values for the weights of both irradiated and control bones are given in Figure II. It is quite apparent that there was a greater retardation in growth on the basis of weight than as judged by length, this being obviously due to the fact that the irradiated bones are smaller in diameter as well as shorter in length. It may be noted from Figure II that, during the first few days after irradiation, the treated bones were slightly heavier than the controls. This is not only true for the average values but holds for most of the individual pairs. The cause of this phenomenon is not clear but it is quite possible that analyses of such bones for water, protein, and mineral matter will throw some light on this subject.

The values for phosphatase activity of both irradiated and control bones are given in Figure III. These figures represent milligrams of inorganic phosphorus liberated per hour from a substrate of sodium-beta-glycerol-phosphate by the enzyme in 100 cc. of bone extract (containing 4 grams of bone) at a temperature of 38° C., and at a PH of 8.8. The phosphatase activity of the irradiated bones began a progressive decrease within a few days after treatment and reached a minimal value within a period of from one to three weeks. This period of minimal phosphatase activity was followed by a tendency toward recovery. There is some indication that the phosphatase activity of the untreated bones is also affected—this is being investigated.

Two animals have also been studied in an attempt to determine the location in the bone of maximum depression of phosphatase activity, after exposure to the roentgen ray. The bones were divided into epiphyses, metaphyses, and shafts. The greatest depression occurred in the metaphysis, which is the region of greatest phosphatase activity. In order to determine whether or not the enzyme itself is in-

activated by the roentgen ray, samples of bone extract and blood plasma were exposed to approximately 1,200 roentgens, and determinations of phosphatase activity immediately made on these and samples of the original untreated materials. No differences were detected.

The choice of particular days for sacrificing the animals was arrived at after a number of preliminary studies had been made. It is quite clear that some of the animals, sacrificed within the period of minimal phosphatase activity, may not have been caught at their lowest values. It was originally planned to study these animals over a longer period, but circumstances necessitated our sacrificing a number of them prematurely.

SUMMARY

The influence of roentgen rays on the phosphatase activity of bone was studied in a number of pups, which were exposed over one fore leg to approximately 600 roentgens. Studies were made on the weight, length, and phosphatase activity of both treated and control bones, over periods up to 34 days. There was a retardation of growth as judged by both weight and length. As compared with the controls, the treated bones showed a decrease in phosphatase activity beginning a few days after exposure, reaching a minimum within from one to three weeks, and showing a tendency toward recovery within from four to five weeks.

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THE VALUE OF ARTERIOGRAPHY

REPORT OF A CASE[1]

By EDGAR V. ALLEN, M.D., Division of Medicine, *and* JOHN D. CAMP, M.D., Section on Roentgenology, The Mayo Clinic, *Rochester, Minnesota*

ROENTGENOLOGIC visualization of the arteries of living subjects by means of intra-arterial injection of opaque substances is relatively new. According to Edwards, who has reviewed the subject, the procedure was first carried out in 1923. The method has never gained wide use, probably because of the difficulty in securing thoroughly satisfactory mediums for injection. The ideal arteriographic medium is one which has high radiopacity, does not cause pain when injected, is freely miscible with blood, and has no toxic effect on blood, blood vessels, or on other organs or systems of the body. A variety of substances have been used; iodides and bromides of sodium, strontium, potassium and calcium, proteinated silver salts, iodized oil, skiodan, diodrast, neoiopax, emulsified lipiodol, and thorium dioxide sol (8). Of these, thorium dioxide sol has the greatest opacity and, in our experience, using 8 to 10 c.c., has no obvious and immediate injurious effect on the blood, blood vessels, or on the body as a whole. The possibility of latent radioactivity has been widely discussed (1, 8, 9). Unfortunately, however, this property of thorium dioxide sol has not been sufficiently considered in the literature, in relation to the amount of the substance used. In experimental work, from 1 to 5 c.c. for each kilogram of body weight has been used. In clinical work, for visualization of the liver and spleen, about 1 c.c. for each kilogram of body weight is necessary. In roentgenologic visualization of arteries and veins of the upper extremities, about 0.10 c.c. for each kilogram of body weight is sufficient. Ericksen and Rigler, who have made an extensive study of the possibility of harmful radio-active effects from the use of thorium dioxide sol, consider that even a greater amount than that just mentioned is distinctly harmless. Our

Fig. 1. *Normal Arteries.*—The arteries have smooth contours and their course is direct. There is minimal collateral circulation.

[1] Submitted for publication April 18, 1934.

experience in arteriography has been limited largely to the use of thorium dioxide sol; however, we have found that neoiopax, skiodan, and diodrast are deficient in radiopacity and produce pain when injected into an artery. The problem of finding an ideal arteriographic medium has not been solved, and further investigations are being carried out.

In the past eighteen months we have used arteriography to examine the peripheral vessels in 85 cases. The following conditions were studied: thrombo-angiitis obliterans (3, 4, 5, 7), arteriosclerosis (5), congenital arteriovenous fistula (10), aneurysm of the popliteal artery (6), arthritis, scleroderma, Raynaud's disease, and hypertension. In some cases in which a search was being made for suspected disease normal blood vessels (2) were found (Fig. 1). In addition to peripheral arteries, visualization of the cerebral arteries (11, 12), and of the abdominal aorta has been reported (13). Our studies have been limited largely to the upper extremities, chiefly because only small amounts of thorium dioxide sol are required for good visualization. In all instances the procedure was carried out with the patient under local anesthesia and without incising the skin.

In brief, the findings in thrombo-angiitis obliterans are: "patchiness" of the obliterative process, the three phases of involvement of arteries that depend on the degree of encroachment on the arterial lumens (described elsewhere, 5), extensive collateral circulation, and obliteration of collateral arteries (Fig. 2). The characteristics of congenital arteriovenous fistula are: increased size and tortuosity of arteries leading to the fistula, "pooling" of the medium in the region of the fistula, and absence of filling of the arteries distal to the fistula. In arteriosclerosis, the rather uniform shaggy outline of arteries the lumens of which are reduced in size is characteristic (5). Data on the arteriographic findings in scleroderma, Raynaud's disease, arthritis, and in hypertension will be reported at a later date.

Fig. 2. *Thrombo-angiitis Obliterans.*—The digital arteries are involved in an irregular, patchy manner. Phases of involvement of the arteries, varying from a simple change in contour to complete occlusion, are revealed. The ulnar artery is occluded at the wrist and a long branch runs distally from above the region of occlusion. The greatly increased collateral circulation is indicated by the fine ramifying twigs.

Opinions concerning the value of arteriography vary from those of enthusiasts, who foresee its use as a routine diagnostic measure, to those of others who express a disregard for it. Our own opinion of the method lies midway between these two extremes. In most cases the procedure is likely to be considered an adjunct rather than an absolute necessity to diagnosis, if experience has been gained in analysis of the symptoms and physical findings of a large number of patients with vascular

disease, and if calorimetric, pathologic, chemical, and physiologic studies are carried out. The experienced observer is able to reach a correct diagnosis in a high percentage of cases by inference and by evaluation of the studies mentioned. Arteriography was of no aid in diagnosis in two cases of congenital arteriovenous fistula, but merely served in a confirmatory capacity. It is quite probable, however, that in some cases the method would furnish the only unequivocal information. In only a few cases of thrombo-angiitis abliterans was arteriography the single diagnostic procedure which furnished information of unquestionable value. Studies under way at the present time indicate that scleroderma and Raynaud's disease may present fairly constant roentgenographic characteristics. If such proves to be true, the diagnostic value of arteriography in these confusing conditions will be great.

Fig. 3. Thrombo-angiitis obliterans in a case in which diagnosis could not be made clinically. The distal part of the radial and the proximal part of the ulnar artery are occluded. Extensive disease of the arteries of the palm and of those that go to the fingers is present. The interosseous artery extends into the hand and the collateral circulation is greatly increased.

The chief value of arteriography, in our estimation, lies not in the direction of diagnosis but in determining the pathogenesis of the condition. It gives information of inestimable value regarding the

minutiæ of arterial disease, information which can be secured in no other way. It is to be expected that the absence or presence of organic arterial disease in Raynaud's disease, and the part played by lateral arteries and other adjustments to impaired circulation are portrayed in a manner which leaves little to be desired. The mode of progression of the disease and the compensation for it are clearly out-

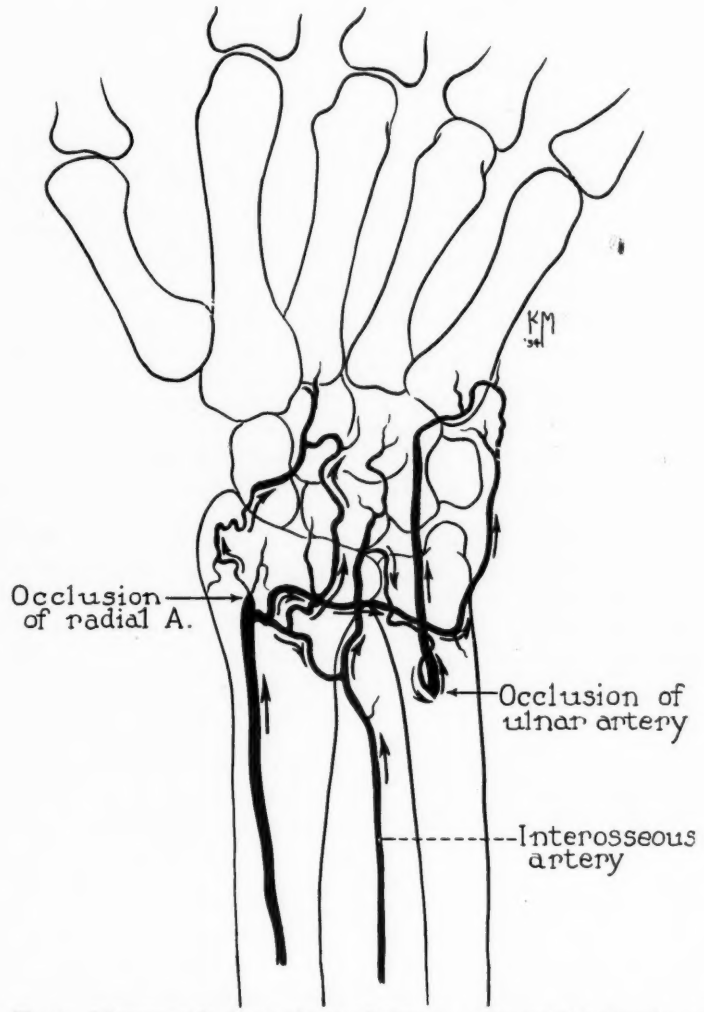

Fig. 4. Diagrammatic sketch of part of Figure 3. The probable direction of the current of blood is shown by arrows. Particularly noteworthy is the increased circulation through the interosseous artery from a branch of the radial artery, the maintenance of circulation in the distal part of the ulnar artery by branches from the interosseous and radial arteries, and the long branch of the radial artery which passes to the ulnar side of the wrist.

disturbances in the arterial circulation in scleroderma, can be determined. In thrombo-angiitis obliterans, the relation of collined. These observations appear to hold true for thrombo-arteriosclerosis obliterans, although our experience with arteriography

in this condition has been distinctly limited. In addition, the situation, extent, and nature of aneurysms, arteriovenous fistulas, and arterial emboli can be determined accurately by arteriography. Whether or not the method will add information of value to the knowledge of the pathogenesis of arthritis, hypertension, and of other conditions remains to be learned in the future.

There can be little doubt that arteriography will be used more extensively. It is not too optimistic to hope that roentgenologic visualization of the arteries of the living subject will enhance information about the circulation in much the same way that roentgenography has increased knowledge of the digestive and urinary systems.

REPORT OF A CASE

A Greek laborer, aged 35 years, who had smoked on the average of twenty cigarettes a day for twenty-three years, was examined at the Mayo Clinic in February, 1934. Seven months previously the fingers of his left hand had been injured when they had been caught between the door and the jamb of a box car. The nail of the fourth finger had been loosened from its bed and the third finger had been severely bruised. Pain had occurred immediately and had persisted up to the time of admission. Tincture of iodine had been applied to the fingers and the hand had been bandaged. About three months later, treatments had been begun in which and ice pack had been applied to the hand for thirty minutes, three times daily; these had continued for four weeks. During this time the distal half of the third finger had turned black and had become swollen. The patient disclaimed symptoms of phlebitis and of trouble in the lower extremities.

At the time of our examination the distal half of the third finger was gangrenous, the third and fourth fingers were slightly swollen, and pulsations were absent bilaterally in the ulnar, dorsalis pedis, and posterior tibial arteries and diminished in the left radial artery. There was moderate abnormal pallor of both feet and of the fingers of the left hand, on elevation, and moderate abnormal rubor, on dependency.

An arteriographic study of the left forearm and hand was made. The resulting films revealed complete occlusion of the radial artery, distal to about the lower end of the radius, and occlusion of the ulnar artery, proximal to a point 3 cm. above the distal end of the ulna (Fig. 3 and 4). The interosseous artery extended into the hand, and the palmar arches and digital arteries were extensively diseased.

COMMENT

The problem in this case was to determine whether trauma alone was responsible for the patient's condition or whether there was some primary disease of the arteries. As a result of experience in other instances, the assumption that a chronic occlusive disease of the arteries had existed before the trauma was entirely reasonable. This assumption was strengthened by evidence of chronic occlusive disease of the arteries of the lower extremities. However, conclusive evidence was lacking; hence, arteriography was performed. On the basis of the findings from this procedure a diagnosis of thrombo-angiitis obliterans was made.

The remarkable compensation for occlusion of the chief arteries is clearly shown in the roentgenogram. In spite of the fact that the distal portion of the radial artery and the proximal part of the ulnar artery are completely occluded, the circulation to the hand and to the fingers, exclusive of the third finger, is adequate to maintain normal function. This physiologic compensation is effected by projection of the interosseous artery into the hand (beyond normal limits), by branching from the radial artery at the point of occlusion, by a large branch arising from the radial artery just proximal to the point of occlusion, by a cross-branch connecting the interosseous artery and the uninvolved portion of the ulnar artery,

and by numerous small arteries arising from those just mentioned. The circulation through the ulnar artery is maintained by a branch from the interosseous and radial arteries.

The roentgenographic studies in this case indicate not only the diagnostic value of arteriography, but also the powers of compensation for disease which are inherent in the arterial system.

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THE TREATMENT OF NEVI: A REVIEW OF CASES TREATED DURING THE LAST FIFTEEN YEARS, WITH ANALYSIS OF END-RESULTS[1]

By WILLIAM S. NEWCOMET, M.D., *Philadelphia*

THE results obtained from the use of radium in some cases of hemangiomas are all that may be desired. Instances have been seen in which large tumor masses have entirely disappeared without any sign of scarring, and the overlying skin was absolutely perfect.

Many cases come under observation in which some surgical procedure has been employed, followed by recurrence of the mass and large scars, which make them more difficult to treat. Frequently, the blood vessels have enlarged beyond the previously involved area, giving a crater-like shape to the tumor, while in others, especially those cases in which carbon dioxide snow has been employed, large ulcers are seen. It would seem logical, therefore, that some mild irradiation should first be used and, if it fails, then resort to surgery. The method for the eradication of these troubles depends largely upon the following factors: (1) condition of the nevus when seen by the physician; (2) the previous history; (3) the histologic formation of the mass.

For convenience in treatment, a purely arbitrary division has been adopted in this review of 506 cases of nevi, as follows: (1) hemangiomas, with subdivisions of different grades into capillary and cavernous, which comprised the largest, and totaled 422 cases; (2) lymphangiomas, which numbered 14 cases; (3) fibroangiomas, including the various forms of moles, which amounted to 70 cases.

The difference between the rather large first group of hemangiomas and the small third group, including moles, is explained by the fact that, as a rule, when moles first appear upon the body they are small and are seldom brought to the attention of a physician until they become troublesome or large enough to cause disfigurement. If all cases of moles were recorded, the proportion in this review would no doubt be entirely different.

The type of nevus most susceptible to irradiation is the cavernous hemangioma. Its history is quite distinct and differs from the others in that at birth, or shortly afterwards, a small spot is noticed which enlarges rapidly (within a few days, weeks, or sometimes a few months), then becomes stationary or may still continue to enlarge slowly. The history of the capillary type is not so distinct and there is some element of doubt as to its formation. Although many individuals will contend that nothing was seen at birth, a few days later the discoloration will be noted but, as time progresses, very little difference in its size and character will develop. The fact that these marks are flat and of no distinct tumor formation, naturally makes detection at birth rather difficult, due to the incidental discoloration of the child's skin. Moles are usually observed at birth, and show little change as time advances, and to some extent this is true of lymphangiomas.

All three of the above-mentioned classes may remain stationary for years and then, for some unknown cause, enlarge rapidly. Cases have been known in which a small spot of one or two millimeters will enlarge within a month to a centimeter or more. At times this growth is associated with some trifling injury. In the adult, this is practically the only type that comes before us for medical treatment. A histologic study of all the different forms of nevi would prove interesting but it would be impossible to obtain enough tissue sections to make comparisons of the various types.

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

Fig. 1. Hemangioma of forearm. R. M. C., 8 months of age, whose forearm became red two weeks after birth. Five weeks later the arm began to swell; one month before coming under observation it began to ulcerate. This case represents a rather common type of complication. (For other cases see References 3 and 4.)

Fig. 2. Same case as shown in Figure 1. Arm presents the usual scarring seen in those cases accompanied by spontaneous ulceration. Due care must be given all cases of angiomas treated by any measure, otherwise the operation will be blamed for this rather frequent complication. A number of radium treatments were given over appropriate areas while the ulceration was in progress.

MALIGNANT CHANGE IN NEVI

There is a well-grounded idea existing among the public that to treat a nevus is to invite malignancy, yet, on the other hand, it is a well-established fact that many cases of malignancy start from nevi. Unfortunately, even with the publicity that has been given to this subject, there still remains, among a certain class, constant fear that it is dangerous to remove nevi.

In this series, only three cases were observed in which there was malignant degeneration. This by no means gives the correct ratio, as it is not unusual, while taking the history of an epithelioma, to have the patient state that it began from a small spot or mole. Two of these three cases had large pigmented moles in which the breaking-down process had just started. One was upon the forehead and the other upon the back, and both promptly yielded to treatment with radium. They were included in this list because they were referred for treatment under the above head. The third case was a girl, six years of age, who had a large hemangioma of the face extending over the right and left cheek, involving the upper lip and nose. The front teeth and premaxillary bones were enlarged, causing the upper teeth to project well beyond the lower jaw. She was treated with radium for some time, with no result except scarring. About five years later she was again seen. During that time she had developed an ulcer upon the face, upon which various procedures had been tried—excision, skin grafting, and various forms of cautery. Healing was only temporary, and finally it developed into a rodent ulcer. The nose and upper jaw became involved, terminating in death at the age of fourteen. It would be interesting in this case to know just what influence the irradiation had upon the termination.

SPONTANEOUS ULCERATION

A number of cases, mostly cavernous hemangiomas, have come to notice with extensive ulceration from no assignable cause, while another group was attributed to a trifling injury. Reference has been made to cases in which the ulceration brought about a cure, but such a fortunate ending was not observed in any case of this group. The place where the ulceration occurred was usually marked by scarring that was not seen in those cases of similar size that had been reduced by irradiation, and the amount of disfigurement was much less than would be expected from the appearance of the ulcer. In several of these cases of spontaneous ulceration, the conditions for a time were quite alarming. An area would become gangrenous and extend in various directions without any particular reason, or, strangely enough, it might begin in several

other areas independent of the original site. The gangrenous condition is similar in its general appearance to those cases of moist gangrene and, while it may be due to some infection, the direct cause would appear to be a clot choking the circulation in the vessels. Naturally the general symptoms are proportional to the involved area. Spontaneous ulceration is more than a passing interest, and should lead to serious thought in cases in which treatment of these tumor masses by irradiation is to be considered.

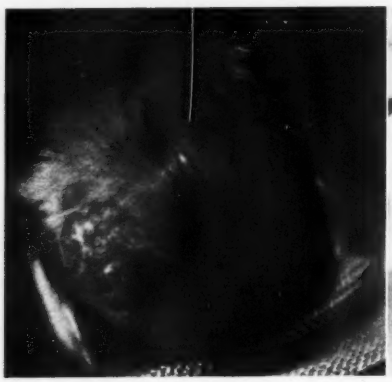

Fig. 3. Hemangioma of head. M. U. R., 11 months of age. Photograph taken Dec. 16, 1926. When the patient was two months old the hemangioma was the size of a quarter, gradually increasing until it attained its present size (4 cm. in diameter, 2 cm. in height).

Fig. 4. Same case as shown in Figure 3. Treatment by 100 mg. radium, given in two positions, 2 hours each, elevated at 2 centimeters. Seven applications were given between Feb. 10, 1927, and Jan. 24, 1928. Note the growth of hair over involved area.

It would be natural to suppose that the trauma, from the irradiation, would be sufficient to cause a reaction similar to that seen in ulcerative cases. While there have been a number of cases in which the reaction was much more intense than was desired, it has never had the character of that seen in the spontaneous cases, nor was the scar the same. From excessive reaction, the scar has a scaly appearance for some time, even several years, while the scar in the spontaneous cases is usually hard and firm, with some tendency toward the formation of keloid.

The element of dosage cannot at all times be correctly estimated and to some extent, it explains the disappearance of masses of considerable size, in cases in which only an extremely weak application has been given. As a general rule, in cases in which the vessels are covered with a good layer of skin, the result will be better and there will be less danger of ulceration than in those cases in which the large vessels are practically exposed, with very little true skin for their protection. It will usually be observed that in cases in which the mass is composed of spongy vessels, the amount of irradiation needed is small, as they yield easily, but if the mass is more or less fibrous, the resistance is greater. This factor also explains the difficulty in treatment of the "port wine stain." The vessels are small, under these circumstances they show a stronger resistance, and the relation to the surrounding tissues is greater. At the same time, this fact must be coupled with the difficulty of obtaining an even reaction over the involved area.

DISTRIBUTION

The distribution of these marks is interesting and, while many are complicated by having several areas involved,

only those were noted which were of sufficient size to warrant attention.

Abdomen	4
Arm	26
Arms, etc	6
Back	19
Body	8
Chest and shoulder	14
Face	303
Face, etc	8
Face, neck	4
Hand	14
Head	27
Legs	20
Mouth	7
Neck	20
Penis	1
Tongue	16
Tongue and mouth	3
General	6
Total	506

By examining this list one is forced to observe that by far a greater number of these marks were upon the exposed parts of the body, 303 of the 506 being upon the face. The argument is often advanced that personal appearance enters largely into consideration. Most of these cases, however, were small children brought for treatment more in alarm of serious consequences than concern about the defect itself. In the adult, personal appearance may be a factor, since in this list 349 were females while only 157 were males. We find also, as a rule, that marks upon the covered parts of the body are not neglected, and the men who have reached maturity are as persistent in their treatment as the women.

A number of hemangiomas have been observed about the female genitalia, but only one in a male. It was a small tumor mass 15 by 10 mm. in diameter, elevated 6 mm., and situated on the upper surface of the glans. It was fairly resistant to the direct method of treatment.

Nevi are unusual in the colored race. In this group only one case was seen, a girl seven years of age, who was sent in as a case of lymphangioma. The mass had been removed by operation but promptly recurred. At the time of observation there was a tumor on the face directly above the angle of the jaw, about 3 by 4 cm. in diameter, elevated 1.5 cm., and composed of three rather distinct nodules. It was given three mild applications of radium, with no effect. Irradiation was not pushed, for the reason, as is well known, that the after-effects upon the skin of the colored race, due to the loss of pigment, are often more displeasing than the original trouble. A number of years later this girl again came under observation. The mass was still practically of the same size, but a biopsy, studied by another pathologist, pronounced it a fibro-angioma. Therefore, if it were either a fibro-angioma or a lymphangioma, considerable irradiation would be required and the probable end-result would not justify such a procedure.

TREATMENT

The treatment of these cases depends largely upon the history of development and the character of the nevi. As most of them appear upon the exposed surfaces of the body, a good cosmetic result is usually desired. In some of the cases of cavernous hemangioma, it is possible to have the mass entirely disappear with absolutely no trace of any change in the overlying skin, but in cases in which there has been widespread displacement of the skin elements by the enlarged blood vessels, or a decided increase in the fibrous elements, some scarring is to be expected. This scarring at times is best corrected by some surgical procedure. The question might be advanced: "Why irradiate in the beginning if some surgical procedure is necessary in the end?" The reason is that many of these masses will extend about the periphery if not irritated before an operation. Furthermore, if the mass is removed by irradiation, the field of operation is smaller. Some surgeons will contend that it is difficult to remove the scar from the irradiated part. On the other hand, it must be admitted that the bleeding which is usually present during the removal of these masses, is greatly reduced by irradiation. This factor alone should be considered. It seems justifiable,

then, to adopt the rule that, in all cases, irradiation should first be tried.

Generally, the more time taken in the treatment of these cases the better will be the result, particularly in younger children.

In contrast to the deformity due to atrophy, the return to normalcy of the part, by removal of the offending mass may be mentioned. This was well exemplified by the removal of a large cavernous hemangioma involving the mouth on the right side and pressing the temporary teeth inward. The permanent teeth are now in perfect line, symmetrical, and perfectly sound, with no distortion of the soft parts.

Fig. 5. Hemangioma of the lip. W. S., 5 years of age, in whose case hemangioma was first noticed when the patient was 8 months old, gradually increasing in size until it was 3 cm. long and 2 cm. wide. The teeth were displaced inward.

Fig. 6. Same case as shown in Figure 5. Result from application of four radium needles of 12.5 mg. each, monel metal, inserted into mass for 4 hours. One month later, a 50 mg. local application was given for 20 minutes, filtered by 0.3 mm. silver. Note that the permanent teeth are in line.

In cases in which intense irradiation is necessary, due care must be given to the fact that the treatment will not only inhibit the mass, but also the growth of the surrounding tissues, as growing tissues are highly susceptible to irradiation. While the results may not be apparent at the time or immediately after the treatment, when the child matures a decided lack of development in adjacent tissues will be noticeable. In certain instances this atrophy cannot be avoided and under ordinary circumstances will not be noted, but some cases in which the defect has caused considerable distress have been brought to our attention. One particular case, when seen years after treatment of the tongue, showed that organ to be only about half its natural size and could not be projected beyond the line of the teeth.

Because of the susceptibility of the surrounding parts, nevi should always be irradiated with radium, and not with roentgen rays. It is evident that it is easier to confine the effects of radium to a limited area.

A number of large hemangiomas occurring in the scalp have been treated with remarkably good results. They ranged in size from 2 to 4 cm. in diameter, were usually regular in outline, and were elevated from 0.5 to 1 cm., with little or no hair on them. Under such circumstances, a bald spot of the same dimensions would naturally be expected to follow treatment because of the displacement of the skin elements by the tumor, and the effects of the irradiation. With the exception of those patients who had had either surgical operations, caustics, or CO_2, in all of the cases with hemangioma of the scalp, a year after treatment, the affected area could scarcely be found, hair having almost completely covered the site of the former mass. As a rule, these tumors upon the head are highly susceptible to

irradiation and can be easily treated by the cross-fire method.

In contrast to hemangiomas occurring upon the head are those upon the hands, where they appear to be unusually resistant and likely to be injured during the course of treatment. Infection of the area of radium reaction will result in a rather severe scarring. Extensive surface involvements, with fine open network of either flat or slightly raised vascular areas, irregular in outline and interwoven with areas of normal skin, so often seen upon the arms or legs, are usually hard to treat. If they show no sign of extension, the use of the electric needle will give fair results. On the other hand, if there is a tendency toward growth, irradiation should be employed to obtain the best results.

Fig. 7. Hemangioma of foot. Notice the scar, resulting from operation. The mass, as frequently observed, is larger.

Fig. 8. Fibrohemangioma of lip. D. M., 14 years of age, had had two operations performed upon the upper lip. Note recurrence of the growth—there is also a loss of sensation and muscular power.

Aside from these large cavernous hemangiomas that at times produce large tumor masses and yet yield easily to irradiation, are those which on the surface appear only as "port wine stains." The fine dilatation of the vessels would appear to be on the surface only, and, it has been pointed out, if the skin can be bleached by slight pressure, the superficial character of the lesion is confirmed. This is not always true, however, and vessels extend deeper than is usually supposed. A number of cases have been seen to support this fact. This is particularly well emphasized by the case of a young girl who had a faint pigmentation of the skin of the left arm, from the hand to the shoulder, the left breast, and chest wall. The left breast was decidedly larger than the right, and a roentgenogram of the bones of the arm and hand showed that those in the left side were larger than those in the right. The skin over the involved area was a faint red and could be easily bleached by pressure. In this case nothing was to be gained by any form of treatment. Attention is called to the fact that in these extensive capillary hemangiomas the process is widespread and scattered through the different tissues with more or less uniformity, while in the cavernous type, the tumor mass may be extensive yet the dilated vascular area may remain distinct without appearing to be an integral part of the other tissues.

COMPLICATIONS

At times, unforeseen complications will arise, but while the employment of radium has little to do with either the cause or result, its use invariably incurs a certain amount of censure. In one instance a young girl developed measles. The nevus had been mildly treated, but the inflamma-

tory condition of the skin caused some ulceration, with considerable infection of the surrounding tissue. After recovery, the nevus appeared to show very little change, yet her parents refused further treatment. Several cases became infected with impetigo contagiosa, which gave rise to some anxiety until the diagnosis was established.

When extensive areas are treated in children, especially the very young, they will often develop a toxic condition, with a more or less general systemic reaction and fever of a mild type. This is accompanied with eruptions upon the skin, usually a number of furuncles. In others, patches of eczema will appear not confined to the local area, but scattered over the body. This complication has been observed in a number of instances, when the local area otherwise showed no sign of reaction. The symptoms, as a rule, are not alarming, and usually subside in a week or ten days. The condition of the child's general health does not seem to influence the severity of the symptoms. Well-nourished children often appear to be more affected by this reaction than those who are undernourished. It is evidently due to absorption of products produced by the disintegration of the cells in the nevus. One case in which this reaction was unusually severe, was that of a small girl, with a large mass extending from the line of the jaw on the left side of the neck to the shoulder and down into the chest along the anterior wall. The skin covering the area was perfect. Several times, when the applications were made, it was supposed that the patient suffered from pneumonia. The mass in the neck promptly disappeared, but because of the severe reaction and the possibility of deep tissue changes, it was decided not to treat the chest. Outwardly the result was perfect, but the roentgenogram still showed a rather extensive shadow in the left chest.

In the smaller nevi, in which the reaction produces a mild degree of erythema, often attended by a slight burning or itching sensation, it is well to keep the parts protected, as scratching or rubbing may lead to abrasions and consequent infection. To obtain a satisfactory result, ulceration should be avoided, if possible

Injury to the affected part during the stage of reaction usually produces more scarring. One unfortunate case was that of a small boy with a large hairy mole upon the right cheek. During the time he was undergoing treatment, his clothing accidentally became ignited, causing a burn upon the shoulder and neck to the upper edge of the mark on the cheek. There was some contraction of the whole scar but the general disfigurement was less than might be expected, considering the size of the area involved. While the burn from the fire might have included the mark, happily it stopped at the upper edge of the area under treatment.

TECHNIC

To give any routine technic for the treatment of nevi in general would be quite impossible since each case must be treated individually. The size, depth, and particularly the structure of the tumor must be fully considered in conjunction with the variation and susceptibility of the skin to irradiation. Children require especial attention in this regard, and it has been our procedure to give a small initial dose, increasing it as the treatment proceeds. Six weeks or two months should elapse between treatments except when a rapid distention of the mass occurs. It has not been our practice to give small repeated doses at frequent intervals, a method which seems dangerous. If the initial dosage is hard to calculate, how much more difficult it would be to determine the amount retained at each application when given in rapid succession.

The apparatus used must be capable of wide variation, and all forms of radium applicators will prove useful. The plaques, tubes, needles, and seeds may be fashioned into various shapes in order to give an even amount of irradiation to the whole mass at the same time. It is this

evenness of application that produces the smooth result. When radium is applied unevenly and areas are omitted, it will be found extremely difficult, with further treatment, to balance the edges with other parts.

Under ordinary circumstances, the greater number of these cases were treated by the direct or cross-fire method, calculating a dosage so as to give about two-thirds of an erythema to the deeper layers. In small marks, with about a millimeter elevation, the radium has been applied directly to the surface by a plaque or tubes evenly distributed over the area. Usually about 0.2 mm. of lead, or its equivalent, was used to filter out the low rays. The high beta rays have been employed, as they materially cut down the time of application, and the results seem to equal those secured in cases in which the filter has been one, two, or three millimeters of lead. The error in this method is that, the farther the radium is raised, the greater will be the depth dose, and that certainly is not desired.

In those cases in which there is a considerable tumor mass, the cross-fire method is usually employed, calculating the dosage so as to give its maximum in the deeper layers with as little effect upon the overlying structure as is consistent. When this cannot be effected or when the tissues are resistant to radiation, and the overlying skin is in danger of destruction, it is best to implant the radium. When this method was employed in this series, the ordinary monel needle was used, with no untoward results that could be ascribed to the choice of filter.

While gold seeds may be employed in cases in which interstitial treatment is desired, it seems unnecessary to leave some foreign body in a mass of this character. Small radon seeds (gold) are valuable in cases in which minor areas are to be treated in parts, and shields of various forms cannot be properly placed. In such cases it should be remembered that the time of application must be very short for the reaction is usually intense.

In concluding these remarks upon technic we would not stress the adoption of any one method. The cardinal rule for all treatment should be to avoid an excessive amount of irradiation. The application may be repeated if not sufficient but an excessive amount of irradiation cannot be recalled and no antidote can be given. Often the effects of severe treatments are most difficult to repair and will produce an objectionable cicatrix.

Fig. 9. Hemangioma of neck and chest. M. McC., 2 months of age. A mass upon the neck was treated with 100 mg. radium, nine positions, 1 hour each, filtered by 1 mm. lead and 7 mm. wood. The first application was in May, second in September; no local reaction. The mass in the neck disappeared. Symptoms of a bronchopneumonia developed after each application, and treatment of chest was not deemed advisable.

COMMENT

The tabulation of results would be most desirable. This, however, is more or less impossible, except when the individual case can be considered. In one instance, there may be a large, most disfiguring mass, and a pleasing result cannot be expected. Yet, with the application of a minimum amount of radium, the mass yields and the overlying skin is left perfect, with the affected part appearing normal. Again, a mass perhaps only half the size of the former will shrink and leave

a surface of scar tissue devoid of color and the natural skin elements, including the fine hairs, all of which are so essential to the natural tone of the involved area.

In those cases in which the trouble occurs upon the face about the eyes, special attention is required and a thorough examination should be made before treatment. The enlarged vessels often involve the eye and, when the mass shrinks, exposing the eye, it will be found to be imperfect. If attention to such a condition has not been given previous to the application, it is liable to reflect discredit upon the radium treatment.

To a lesser extent, this is also true of the cases involving the nose and throat.

It is possible, in most instances, to prognosticate the result, and this should be done, especially in those cases in which a perfect result is not expected. Circumstances alter cases to such an extent that a method of treatment meeting all requirements in one condition may be discarded in another seemingly similar one. It is well to present the facts to the patient or his family and prevent disappointment. Always bear in mind that, while these marks may be objectionable, the scar left by their removal may be more so, and in the few cases in which there is no chance to afford relief, treatment should not be undertaken.

A number of small marks close to the eye and upon the eyelid have been treated. The dosage in these cases has been calculated according to the superficial character of the lesion so as not to extend to the deeper structures. In two cases the angioma was upon the upper lid and in both cases there was no reaction upon the under surface—when the marks disappeared the skin was normal. If the tumor mass extends through the eyebrows or lashes, the area has to be left untreated, as these are highly susceptible to irradiation. In children in whom the hair is undeveloped, it is impossible to get a correct balance.

Fig. 10. D. P., 20 months of age, had a tumor, 3 × 2 × 1 cm., upon the upper lip, which was treated by 50 mg. 45 minutes direct contact Six applications were given between February and May.

Fig. 11. Same case as shown in Figure 10, the patient now being 5 years of age. The photograph shows the condition three years after treatment.

There were certain groups in which the results were unusually brilliant. In one group of 12, the end of the nose was involved, giving a most grotesque appearance. The enlargement in several was about the size of a cherry and much that color, while in others it was covered with normal skin. The unusual results in these cases may be due to the fact that the end of the nose can more easily receive the cross-fire treatment from a number of angles. Several of these patients are now adults, exhibiting no sign whatever of previous trouble either in form or skin texture.

A number of other cases have been treated in which the mass was at the bridge or the base of the nose, and, while the results were favorable, they did not compare with the former class. If the tumor mass was at the angle of the jaw, due regard was given to the underlying salivary gland, making it difficult to reach the deeper parts of the tumor. Here again, the results were not so uniform

as were those upon the nose, mouth, or scalp.

In two cases in which the leg was affected with large spongy veins passing from the thigh to the ankle, prolonged treatment proved useless. One case was complicated, with large ulcers about the ankle. These two cases might be compared with the extensive "port wine stain," previously mentioned, in which treatment was not attempted because of the general enlargement of the involved parts.

SUMMARY

In this article the effort has been made to review a large number of cases and group them, in order to show that the results obtained were not temporary, and, as time passed, that no sequelæ followed to mar them. In only a few instances, in which the attempt was made to relieve some unusually distressing case by irradiation, was it necessary to resort to any surgical procedure. Several cases, treated a decade or more ago, have now reached adult life and show some slight deformity of the affected part, due either to the lack of development or to the fact that some of the natural tissues were displaced by the mass. It must be remembered, however, that the younger the child is when treated, the greater will be the possibility of this atrophy, or lack of development. In the majority of cases, results of treatment were very satisfactory. The marks or tumor masses had disappeared, and the sites were practically normal and without scar. No other method could accomplish so much and, while the treatment is not so rapid as in other treatments, the results are better.

These lesions are not dangerous to life, therefore, there is no justification for the employment of any dangerous procedure.

In conclusion the fact is stressed that in all cases the mild application of radium may bring about a diminution of the tumor mass and it should always be used previous to operation. Even in severe cases the reduction of the tumor mass will materially reduce the operative risk.

These deductions have been made from previous publications upon this subject, time now having permitted them to mature. So far, there has been no reason whatsoever to alter them in the least.

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X-RAY TECHNIC FOR CHILDREN[1]

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IN any survey of roentgenographic literature the surprising dearth of material dealing with technic for children will undoubtedly be noticed. Excellent instruction in adult technic may be given, but for child technic, if it is mentioned at all, the reader is offered some such vague direction as "halve the time of exposure for children." The all-too-familiar result of an instruction of that kind is either the transparent-like negative or the densely dark one, neither of which is satisfactory for diagnostic purposes. This article is an attempt to contribute more definite technic within a limited field.

The Iowa Child Welfare Research Station has been engaged in an x-ray program for the past twelve years. Its object has been to study, through this medium, growth and development of normal children from birth to maturity, correlating the results with findings through physical measurements. In anticipation of research projects along this line, the x-ray films have been limited to the bony structure of the body. Because of the greater amount of data on the head and the extremities (about 1,500 exposures), this article will be concerned with them alone. It is hoped, however, that a similar work on the soft tissues and on the other bone structure, not here mentioned, will be forthcoming.

For some years the radiographs were made at the College of Dentistry of the State University of Iowa under the direction of Dr. E. A. Rogers, and it is to his assistance that the writer is indebted for the technical details upon which the present methods have been built. Additional suggestions have also been made from time to time by R. M. Tarrant, head technician at the State University of Iowa General Hospital. The aim has been to use such exposure as will show the maximum amount of detail in bone pattern and density and the earliest nuclei of bone growth. Since knowledge on the ultimate effect of x-rays is incomplete, an attempt was made to give each child the minimum exposure compatible with good results.

The equipment consisted of a Snook machine with which a Universal fine tube was used. Although this tube does not possess the smallest focal spot which is very desirable for ultra-fine bone work, its general practicality for combination service recommended it. A 1 mm. aluminum filter is used at all times. Formerly a target distance of 30 inches was maintained, but now one of 36 inches is used. The appreciation expressed by a seven-year-old and the greater confidence observed in the younger ones warrant this increase of distance, which at the same time affords greater safety. Because of the 6-inch increase, an addition of approximately 9 K.V.P. was necessary to give the same results. The change in distance alters the size of the image very slightly. Baldwin, Busby, and Garside[2] in their comparison of carpal area demonstrated that the variation is within the experimental error in measuring. The technic used in this study is adapted to Eastman Diaphax films; for Contrast films the exposure time was multiplied by 1.5.

The first part of this study deals with infants ranging in age from sixteen days

[1] This study was made at the suggestion and with the helpful advice of Miss S. Idell Pyle, of the Iowa Child Welfare Research Station.

[2] Baldwin, Bird T., Busby, Laura M., and Garside, Helen V.: Anatomic Growth of Children: A Study of Some Bones of the Hand, Wrist, and Lower Forearm by Means of Roentgenograms. Univ. Iowa Stud., Stud. in Child Welfare, 1928, IV, No. 1, pp. 88.

to two years, five months, twenty-nine days. The prereading voltage and consequent secondary voltage, *i.e.*, kilovolt peak, was the only variable used in this group. The second part of this article deals with children of school age from five years, six months, to seventeen years, five months, twenty-nine days, with whom it was possible to use time as the variable. The radiographs have been judged and classified for their adequateness by the writer and two other persons who have worked with the films. The technic here given is the one actually employed with those films which were satisfactory in every detail.

INFANTS

In the early part of this study, hand films of the first group were taken with a very short exposure. The method was for an assistant to place the hand rather suddenly on the film, surprising the child and causing him to hold his hand in position long enough for the exposure of about 0.1 second. Later, however, this method was discarded in favor of one simpler for the technicians, namely, that of holding the hand down with a piece of gauze. It was found that an exposure of 0.3 second could then be used with as high a percentage of accuracy as that secured by the first method. In other words, if the hand could be held at all, it could be held for 0.3 second. The hand technic used is given in Table I.

No intensifying screens were used; instead, the films were placed in the black-and-orange envelopes supplied by the manufacturers. A piece of lead ($^1/_8$ inch thick) was placed at the back of the outer envelope to obviate fogging by secondary radiation during the exposure. An interesting point was brought out when it was decided to take a radiograph of the mother's hand in order to compare its bone pattern with that of the child's hand. The writer was told that it would be impossible to make a single exposure that would give an adequate picture of the child's hand and at the same time show the mother's bone pattern. However, the writer felt justified in making the trial, believing that, even though the roentgenograms might not be as good as those obtained by two separate exposures, yet the added confidence given to the child in having his mother's hand alongside would be worth while. This proved to be true. Often with a child as young as fifteen months it was not necessary to hold the hand in position with gauze, as the child could be persuaded voluntarily to place his hand beside his mother's. Moreover, the mother's roentgenogram gave a considerable amount of detail and entirely filled the desired requirements. When it is realized that for the average

TABLE I.—X-RAY TECHNIC FOR HANDS OF INFANTS FROM SIXTEEN DAYS TO TWO AND ONE-HALF YEARS OLD

Age						Prereading voltage	Kilovolt peak	Time (sec.)	Milli-amperes	Distance (in.)
Years	Months	Days	Years	Months	Days					
		16 to		1	15	106	60	0.3	50	36
	1	16 to		2	15	106 to 111	60 to 63	0.3	50	36
	2	16 to		3	15	106 to 111	60 to 63	0.3	50	36
	3	16 to		4	15	106 to 111	60 to 63	0.3	50	36
	4	16 to		5	15	111 to 116	63 to 66	0.3	50	36
	5	16 to		6	15	116 to 122	66 to 68	0.3	50	36
	6	16 to		7	15	122	68	0.3	50	36
	7	16 to		8	15	122	68	0.3	50	36
	8	16 to		9	15	122	68	0.3	50	36
	9	16 to		10	15	122 to 127	68 to 72	0.3	50	36
	10	16 to		11	15	122 to 127	68 to 72	0.3	50	36
	11	16 to		12	15	122 to 127	68 to 72	0.3	50	36
	12	16 to	1	5	29	127	72	0.3	50	36
1	6	0 to	2	5	29	132	76	0.3	50	36

TABLE II.—HEIGHT AND WEIGHT RANGE OF INFANTS IN THIS STUDY

Age						Height range (in.)	Weight range (pounds)
Years	Months	Days		Years	Months	Days	
		16	to		1	15	18.7 to 22.1	9.0 to 11.50
	1	16	to		2	15	21.3 to 23.3	10.9 to 14.65
	2	16	to		3	15	22.5 to 24.1	12.5 to 14.55
	3	16	to		4	15	21.7 to 27.0	11.0 to 18.40
	4	16	to		5	15	24.6 to 28.0	13.7 to 19.30
	5	16	to		6	15	23.0 to 29.5	14.6 to 22.10
	6	16	to		7	15	25.5 to 29.3	16.1 to 23.30
	7	16	to		8	15	25.7 to 28.5	16.2 to 21.50
	8	16	to		9	15	26.5 to 30.0	17.6 to 25.50
	9	16	to		10	15	27.1 to 29.2	19.2 to 20.30
	10	16	to		11	15	28.9 to 30.3	21.6 to 26.70
	11	16	to		12	15	29.1 to 30.0	20.6 to 24.80
	12	16	to	1	5	29	27.4 to 32.5	17.5 to 26.14
1	6	0	to	2	5	29	29.4 to 36.9	20.4 to 33.10

TABLE III.—MEAN HEIGHT AND WEIGHT FOR INFANTS[3]

Age (mo.)	Boys		Girls	
	Mean height (in.)	Mean weight (pounds)	Mean height (in.)	Mean weight (pounds)
1	21.5	8.6	20.6	8.2
2	22.6	11.0	21.9	9.7
3	24.3	12.8	23.6	12.6
4	25.0	14.6	24.3	13.0
5	26.0	16.3	25.6	15.7
6	26.7	17.6	25.7	15.9
7	27.1	18.1	26.5	17.0
8	27.7	19.6	26.7	18.1
9	28.2	20.5	28.0	19.0
10	28.6	20.7	27.9	19.6
11	29.2	21.6	28.3	20.7
12	29.6	22.0	29.1	20.5
18	32.2	25.1	31.4	23.6
30	36.6	31.1	35.2	29.8

[3] Pyle, S. Idell: Physical Traits of Iowa Infants. Am. Jour. Dis. Child., 1931, XLII, 1137–1143.

woman's hand but 0.4 second more exposure is necessary than for that of the six-month-old child, the satisfactory results are not so surprising.

In classifying the infants' roentgenograms, groupings were made according to age, height, and weight. As a rule, previous investigators have emphasized the importance of the size of the individual in calculating the factors governing the technic used. It appeared that for the group used in this study, however, age was the prime factor to be used in controlling the technic, and the tables given here are arranged according to age. At the time of exposure the infant's age was not persistently ascertained; instead, a cursory appraisal of skeletal development usually determined the operator's choice of kilovolt peak. Height proved to be an inadequate criterion. In a study of two groups, one ranging in height from 26.7 inches to 27.7 inches and the other from 30.7 inches to 32.5 inches, there was a variation of from 6 to 8 kilovolts peak. The inadequacy of height as a criterion is clearly shown by the great range in age within each of these groups: first group, children from five to thirteen months; second group, children from thirteen months to two years. Weight showed a still wider variation. A grouping of those weighing from 17 pounds, 6 ounces, to 21 pounds, 6 ounces, included children from four months to twenty-two months, fifteen days—children who would obviously require the use of differing kilovolt peak and who did actually run a range of 13 kilovolts peak. A second grouping of those weighing between 10 and 20 pounds included children from one month, nine days, to one year, five months, eight days, of age and ran a range of 12 kilovolts peak. In each group this showed but 3 K.V.P. less than the whole gamut.

It would appear then that body weight of the infant is of less importance than height and of still less importance than age in determining x-ray technic to be used for exposures of the extremities. However, age cannot be taken as an absolute criterion, for just as different substances present resistance to the x-rays in varying degrees according to their atomic weight,

so also the individuals present a radiopacity that varies possibly because of the differing constituency of the bone, fat, muscle, and skin components. For instance, the pattern of the bone in the really fat child will not be as clearly pronounced on the film as that of the normal child, although the contrasts and density indicate that the right exposure was given. It has been suggested that this condition is due to fat within the bone as well as tissue fat. The height and weight range of the children in this group is shown in Table II. Table III indicates that these infants were of average height and weight by giving the averages for boys and girls of these ages.

In taking roentgenograms of the foot, the child was either placed on the table on his back or held in a semi-sitting posture by the assistant. Except in a few rare instances, no gauze was used to hold the foot in position. As this work is done primarily for research, an effort is made whenever possible to avoid distressing the child by such constrictions and to avoid distortion of the parts. For the anteroposterior view, the foot was placed in a walking position on the film, the assistant maintaining it in this position by holding the child's knee. Table IV gives the technic used.

The position for the lateral view of the foot is a very natural one for the infant and one that is usually unconsciously maintained without aid. Ordinarily 3 K.V.P. more than the anteroposterior exposure gives the necessary voltage for

TABLE IV.—X-RAY TECHNIC FOR ANTEROPOSTERIOR VIEW OF FOOT FOR INFANTS FROM SIXTEEN DAYS TO TWO YEARS, SIX MONTHS, OLD

Age						Prereading voltage	Kilovolt peak	Time (sec.)	Milli-amperes	Distance (in.)
Years	Months	Days	Years	Months	Days					
		16	to	1	15	111	63	0.3	50	36
	1	16	to	2	15	111 to 116	63 to 66	0.3	50	36
	2	16	to	3	15	111 to 116	63 to 66	0.3	50	36
	3	16	to	4	15	111 to 116	63 to 66	0.3	50	36
	4	16	to	5	15	116 to 122	66 to 68	0.3	50	36
	5	16	to	6	15	122 to 127	68 to 72	0.3	50	36
	6	16	to	7	15	127	72	0.3	50	36
	7	16	to	8	15	127	72	0.3	50	36
	8	16	to	9	15	127	72	0.3	50	36
	9	16	to	10	15	127	72	0.3	50	36
	10	16	to	11	15	127	72	0.3	50	36
	11	16	to	12	15	127 to 132	72 to 76	0.3	50	36
	12	16	to 1	5	29	132	76	0.3	50	36
1	6	0	to 2	5	29	137 to 141	80 to 83	0.3	50	36

TABLE V.—X-RAY TECHNIC FOR LATERAL VIEW OF FOOT FOR INFANTS SIXTEEN DAYS TO TWO YEARS, SIX MONTHS, OLD

Age						Prereading voltage	Kilovolt peak	Time (sec.)	Milli-amperes	Distance (in.)
Years	Months	Days	Years	Months	Days					
		16	to	1	15	111	63	0.3	50	36
	1	16	to	2	15	116	66	0.3	50	36
	2	16	to	3	15	122	68	0.3	50	36
	3	16	to	4	15	122	68	0.3	50	36
	4	16	to	5	15	122 to 127	68 to 72	0.3	50	36
	5	16	to	6	15	127	72	0.3	50	36
	6	16	to	7	15	127 to 132	72 to 76	0.3	50	36
	7	16	to	8	15	127 to 132	72 to 76	0.3	50	36
	8	16	to	9	15	132	76	0.3	50	36
	9	16	to	10	15	132	76	0.3	50	36
	10	16	to	11	15	132	76	0.3	50	36
	11	16	to	12	15	132	76	0.3	50	36
	12	16	to 1	5	29	132 to 137	76 to 80	0.3	50	36
1	6	0	to 2	5	29	137 to 145	80 to 86	0.3	50	36

the added thickness of the lateral view. The technic used is given in Table V.

The data on the head technic for infants are not sufficiently complete to be presented here.

The lateral elbow was radiographed while the child was held on either the mother's or the assistant's lap parallel with the table. In an effort to support himself the child would so hold the elbow over the film as to give opportunity for the exposure. When an anteroposterior view of the elbow was required, the arm was held out by taking hold of the hand. The technic for exposure was in each case the same as that used for the anteroposterior foot. The anteroposterior view of the knee was not taken as a matter of routine. When it was required, the technic used was 3 K.V.P., or one unit, according to the calibration of the machine, above that used in the lateral foot technic for a child of the same age.

This completes the record of the technic used on the extremities of infants. It will be noticed that as the age increases the variation in the exposure factors becomes less. Several months might have been grouped together, as is done in the age-group from twelve months, sixteen days, to one year, five months, twenty-nine days, but the grouping of the months would have varied somewhat in each chart. Therefore, it was thought that the arrangement used was more consistent. It is obvious that as age increases the rate of growth decreases, and groupings covering a larger age range can thus be made.

SCHOOL CHILDREN

The x-ray exposures were limited to head, hands, and feet for the school-age children comprising the second group. Intensifying screens were used for the head exposures, but for the hands and feet the black-and-orange envelopes, backed

TABLE VI.—X-RAY TECHNIC FOR LATERAL VIEW OF HEAD AND RANGE OF TRANSVERSE HEAD MEASUREMENTS FOR CHILDREN OF SCHOOL AGE

Age						Pre-reading voltage	Kilovolt peak	Time (sec.)	Milliamperes	Distance (in.)	Range	
Years	Months	Days		Years	Months	Days						Meatus	Parietal
5	6	0	to	6	5	29	106	60	0.30 to 0.50	50	36	11.0 to 11.8	13.8 to 14.8
6	6	0	to	7	5	29	106	60	0.40 to 0.50	50	36	11.0 to 12.0	13.2 to 14.2
7	6	0	to	8	5	29	106	60	0.40 to 0.50	50	36	11.4 to 12.2	13.2 to 14.6
8	6	0	to	9	5	29	106	60	0.40 to 0.50	50	36	11.6 to 12.4	13.8 to 14.6
9	6	0	to	10	5	29	106	60	0.50 to 0.75	50	36	11.6 to 12.2	13.8 to 14.6
10	6		to	11	5	29	106	60	0.75 to 1.00	50	36	12.4	14.2
11	6		to	12	5	29	106	60	0.75 to 1.00	50	36	12.6 to 13.8	14.2 to 14.6
12	6		to	13	5	29	106	60	0.75 to 1.00	50	36	12.0 to 13.0	14.2 to 14.8
13	6		to	14	5	29	106	60	1.00	50	36	12.6 to 13.6	14.6 to 15.2
14	6		to	15	5	29	106	60	1.00	50	36	13.2 to 13.8	14.4 to 15.4
15	6		to	16	5	29	106	60	1.00	50	36	12.6 to 13.4	14.4 to 14.8
16	6		to	17	5	29	106	60	1.00 to 1.50	50	36	12.8 to 14.0	14.2 to 16.2

TABLE VII.—X-RAY TECHNIC FOR HANDS OF CHILDREN OF SCHOOL AGE

Age							Pre-reading voltage	Kilovolt peak	Time (sec.)	Milliamperes	Distance (in.)
Years	Months	Days		Years	Months	Days					
5	6	0	to	6	5	29	102	56	0.40 to 0.50	50	36
6	6	0	to	7	5	29	102	56	0.40 to 0.50	50	36
7	6	0	to	8	5	29	102	56	0.40 to 0.50	50	36
8	6	0	to	9	5	29	102	56	0.50	50	36
10	6	0	to	11	5	29	102	56	0.50 to 0.75	50	36
11	6	0	to	12	5	29	102	56	0.75 to 1.00	50	36
12	6	0	to	13	5	29	102	56	0.75 to 1.00	50	36
13	6	0	to	14	5	29	102	56	1.00	50	36
14	6	0	to	15	5	29	102	56	1.00	50	36
15	6	0	to	16	5	29	102	56	1.00	50	36
16	6	0	to	17	5	29	102	56	1.00 to 1.25	50	36

by lead, were used as with the infants. A lateral view was taken of the head, an effort being made to procure a good film of the dental development of the left side of the head, upper and lower mandibles, depth and breadth of the ramus, the sella turcica, and the general contour of the skull. It was found that the best way to do this and to avoid superimposition of the parts was to give an 18- to 20-degree tilt of the tube toward the head. When the tube is thus tilted and 36 inches from the table maintained, the central ray is elongated some 2.5 inches and a compensation of either distance, kilovolt peak, or time must be made. This, however, is taken into consideration and adjustment made in the technic given. The child is placed on the table in a prone position, the hands at the side and the head turned to the right. If it is necessary to improve the angle, a small pillow or sandbag is placed under the chest.

Measurements were taken of the head

TABLE VIII.—X-RAY TECHNIC FOR ANTEROPOSTERIOR VIEW OF FOOT FOR CHILDREN OF SCHOOL AGE

Age							Pre-reading voltage	Kilovolt peak	Time (sec.)	Milliamperes	Distance (in.)
Years	Months	Days		Years	Months	Days					
5	6	0	to	6	5	29	106	60	0.40 to 0.50	50	36
6	6	0	to	7	5	29	106	60	0.50	50	36
7	6	0	to	8	5	29	106	60	0.50	50	36
8	6	0	to	9	5	29	106	60	0.50 to 0.75	50	36
10	6	0	to	11	5	29	106	60	0.75	50	36
11	6	0	to	12	5	29	106	60	0.75 to 1.00	50	36
12	6	0	to	13	5	29	106	60	0.75 to 1.00	50	36
13	6	0	to	14	5	29	106	60	1.00	50	36
14	6	0	to	15	5	29	106	60	1.00 to 1.25	50	36
15	6	0	to	16	5	29	106	60	1.00 to 1.25	50	36
16	6	0	to	17	5	29	106	60	1.00 to 1.50	50	36

TABLE IX.—X-RAY TECHNIC FOR LATERAL FOOT FOR CHILDREN OF SCHOOL AGE

Age							Pre-reading voltage	Kilovolt peak	Time (sec.)	Milliamperes	Distance (in.)
Years	Months	Days		Years	Months	Days					
5	6	0	to	6	5	29	111	63	0.50	50	36
6	6	0	to	7	5	29	111	63	0.50	50	36
7	6	0	to	8	5	29	111	63	0.50	50	36
8	6	0	to	9	5	29	111	63	0.50 to 0.75	50	36
10	6	0	to	11	5	29	111	63	0.75	50	36
11	6	0	to	12	5	29	111	63	0.75 to 1.00	50	36
12	6	0	to	13	5	29	111	63	0.75 to 1.00	50	36
13	6	0	to	14	5	29	111	63	1.00	50	36
14	6	0	to	15	5	29	111	63	1.00 to 1.25	50	36
15	6	0	to	16	5	29	111	63	1.00	50	36
16	6	0	to	17	5	29	111	63	1.00 to 1.50	50	36

TABLE X.—HEIGHT AND WEIGHT RANGE OF SCHOOL CHILDREN IN THIS STUDY

Age							Height range (in.)	Weight range (pounds)
Years	Months	Days		Years	Months	Days		
5	6	0	to	6	5	29	42.0 to 47.6	35.1 to 56.2
6	6	0	to	7	5	29	43.6 to 52.2	40.8 to 41.7
7	6	0	to	8	5	29	49.5 to 54.1	55.6 to 66.6
8	6	0	to	9	5	29	54.4 to 54.5	62.2 to 65.0
9	6	0	to	10	5	29	51.3 to 56.0	62.8 to 66.4
10	6	0	to	11	5	29	61.2	90.8
11	6	0	to	12	5	29	58.1 to 63.9	101.2 to 127.9
12	6	0	to	13	5	29	60.2 to 64.8	63.5 to 107.8
13	6	0	to	14	5	29	61.7 to 62.6	93.7 to 107.6
14	6	0	to	15	5	29	63.5 to 67.5	100.8 to 162.7
15	6	0	to	16	5	29	66.0 to 70.1	112.7 to 157.0
16	6	0	to	17	5	29	66.9 to 73.7	119.9 to 175.5

to determine if they could be used as guides to radiopacity. Head calipers were used, the tips being placed on either side at the external auditory meatus. A second transverse measurement was made about two inches higher at the parietal eminence. These measurements are given in Table VI. Although they indicate a steady growth, they do not at this time present a definite guide to the x-ray technician; on the other hand, they are not without some significance.

In taking hand radiographs, the child was seated on a stool or chair by the table. Both hands were placed on the film and the one roentgenogram taken. Exception was made to this in the cases of large and fat children; in such instances the radius would be rotated if the hands were cramped together on the film. For the same reason the elbows of the other children were kept from spreading and dropped slightly. Table VII gives the hand technic.

For the foot x-rays the child was placed on the table in a supine position. For the anteroposterior view of the foot, the knee was flexed and the foot placed flat on the film as for walking. A 5- to 10-degree tilt of the tube toward the child was made for children over eleven years, six months, of age, and the central ray was directed toward the heaviest part of the foot. The technic used is given in Table VIII.

For the lateral view of the foot the supine position of the body was maintained. The flexed knee was turned outward and placed upon a pillow for stability and comfort. The supine position of the body was preferred to the lateral one sometimes recommended for this view of the foot, because there appeared less rotation of the tibia and fibula and they were not superimposed upon the astragalus. Table IX gives the technic used for the lateral view of the foot.

The height and weight range of the children of school age is given in Table X.

In conclusion, it appears that the technic to be used for the infants' roentgenograms varies with the age of the child rather than with the height or weight. This variation, however, becomes less as the age increases. With the children of school age, age plus skeletal development must be the determining factors. In both groups an exception to general technical results is found in the case of the overfat child, for here the bone pattern will be less clearly pronounced although the general appearance of the film will be satisfactory.

POST-TRAUMATIC PARA-ARTICULAR OSSIFICATION OF THE KNEE JOINT ("KÖHLER-PELLEGRINI-STIEDA SHADOW")

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THE knee joint, because of its anatomical position, is often exposed to varying forms of trauma. In the event of injury the first thought is of a bone lesion, and, because of possible fracture, the patient is sent to the radiographic department. If the report is in the negative, the condition is regarded as a simple contusion, its cure to be effected in a short time with proper treatment or even spontaneously. When the healing is prolonged and the patient continues to complain, other hypotheses may attribute these pains to alterations in the nervous system and even give rise to the suspicion that the patient is malingering. However, repeated radiographic examinations can, in many of these cases, settle the question.

In this paper we wish to consider the structures located at the internal condyle of the femur, described under the names of "Stieda shadow-fracture," "Stieda-Pellegrini fracture disease," "Köhler-Pellegrini-Stieda disease," etc. However, all these terms are inexact and do not correspond with the nature of the changes or the priority of the discovery, and we agree with Petrignani that it is superfluous to designate by a proper name any of the bone lesions of the type under discussion. But even if we wished to follow the custom, it would be more correct to call these "Köhler-Pellegrini-Stieda concomitant shadows" or, as Petrignani prefers, "Köhler-Pellegrini-Stieda syndrome."

In 1905, Köhler, while studying a film, noted for the first time an unusual shadow of the coxofemoral articulation and of the femur, which he regarded as due to an ossification of the connective tissue about the joint. At the same time Pellegrini described the clinical picture, radiology, and histology of a case of post-traumatic ossification in the region of the internal condyle of the femur. These papers did not arouse any special interest and it was not until two years later, in 1907, that Stieda, at the Third Radiological Congress, called the attention of physicians to this structure.

Papers on the important work of Petrignani, Bistolfi, and Fredet, dealing with the question of the concomitant shadow of the knee joint, have appeared during the last three or four years in France and Italy. This question has lost none of its importance even to-day, and a series of publications, with histories of cases, is sufficient proof of that. After an interval of seven years there will be found the works of Michelson, Andreesen, Temler, and Berner in the German literature. Only the editorial (18) which appeared in the "American Journal of Roentgenology and Radium Therapy," in 1932, and the work of Kulowski (7), in 1933, have been found in the American literature. It would seem that this subject has been sufficiently studied and that it is useless to discuss it further. However, we are not reviving it for the purpose of increasing the number of published cases, but in order to try to understand what is meant by the name "Köhler-Pellegrini-Stieda disease," because the nature of the concomitant shadow is not wholly clear, and there is still some question as to the underlying lesion.

It is a shadow (parallel, as a rule, to the bone in the direction of the metadiaphysis) disclosed by radiographic examination three to four weeks after an injury. The injury may be inflicted in either one of two ways: direct or indirect violence (a blow, wound, contusion, or fracture), or it may be a series of small, repeated injuries of an occupational or athletic nature. The struc-

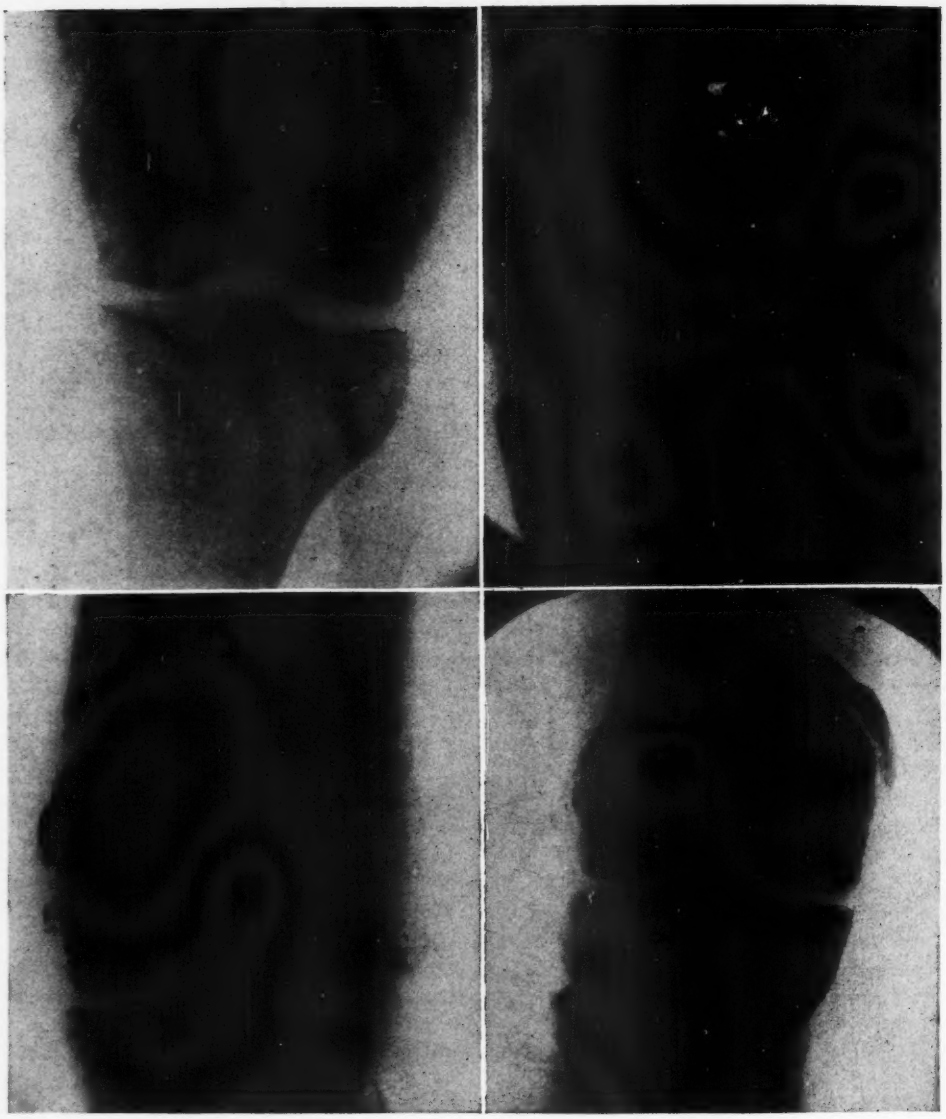

Fig. 1 (*top, left*), Case 1; Fig. 2 (*top, right*), Case 2; Fig. 3 (*lower, left*), Case 3; Fig. 4 (*lower, right*), Case 4.

tures are generally of medium thickness, elongated form, varying degrees of density, separated from the bone by a clear space, sometimes attached to the bone by a pedicle or even fused with it. The clinical symptoms are indefinite, manifesting themselves, in the majority of cases, by vague, painful sensations.

The number of cases published up to the present time totals 300, most of them showing unilateral changes, rarely bilateral, and occasionally multiple alterations. Exceptionally there may be calcification in the region of the intercondylar tubercle.

Following are cited some of the typical

cases, in each of which a traumatism was recorded in the history.

Case 1 (Service of Dr. Zeitlin). Narrow, elongated shadow, 1 cm. × 2 mm., sharp outlines, located in the region of the internal condyle from 2 to 3 mm. from the latter, parallel to the bone, its density corresponding with that of the bone.

Case 2 (Service of Dr. Zeitlin). Oval shadow, distinctly osseous in structure, sharply outlined, occurring at the level of the internal condyle, from 6 to 7 mm. from the bone, corresponding to the middle of the condyle. Another shadow, the width and form of a rice grain, projected in the region of the internal intercondylar tubercle. The interarticular space showed nothing of importance.

Case 3 (Service of Dr. Zeitlin). Greatly elongated shadow formed of separated bands of varying degrees of density, occurring at the level of the superior border of the internal condyle of the femur, distinct from the bone. Its upper border is indistinct. Lower, towards the middle of the condyle, there is a group of small, dense shadows the size of a millet seed. Another shadow composed of small, rounded bands with indistinct edges is located near the inferior edge of the external condyle, from 4 to 5 mm. from the bone. The radiographic film shows two shadows, one in the region of the popliteal fold behind the condyle, the other near the head of the fibula. In addition, there is a fissure in the upper third of the patella. Two other shadows, rice-like in form, project in the region of the intercondylar tubercle.

Case 4 (Service of Dr. Zeitlin). Approximate with the internal condyle is a band, fairly large, with sharp outlines, bony structure, the upper part of which is hidden by the metaphysis of the femur. Another dense shadow, less voluminous, separated from the bone by a space of from 2 to 3 mm., is seen opposite the external condyle of the femur.

Case 5 (Service of Dr. Zeitlin). Elongated shadow separated from the femur by a space of from 2 to 3 mm., in the region of the superior border of the internal condyle of the femur. Its density is the same as that of the bone. Another structure of lesser density, vaguely triangular in shape, can be seen above the inferior edge of the internal condyle, from 3 to 5 mm. from the bone.

Fig. 5, Case 5.

What is, therefore, the anatomical basis for these structures? Stieda, considering the position of the shadow, admits that it is a fracture of the upper part of the condyle of the femur. His conclusion is based on a comparison made with an anatomical specimen presenting analogous changes. Vogel reached the same conclusion from a case operated on, verified by histologic examination. The structure of the portion removed was entirely bony, without trace of periosteum or other connective tissue. However, Vogel remarks that he did not notice at the operation the uneven outlines of the femur characteristic of a rupture. Schaaning, on the other hand, having seen a case two days after injury, showing in the radiograph a shadow in juxtaposition to the internal condyle, which he removed surgically, does not admit of the possibility of ossification at the expense of the periosteal tissue

Fig. 6, Case 6.

Fig. 7, Case 7.

and speaks of the separation of a bony lamella. Andreesen (1), in analyzing his large material, quotes only two cases of actual fracture in support of the extreme rarity of these fresh injuries. Preiser speaks of "periosteal ossification," also called ossification of the separated periosteum. According to Berner (3) trauma and, in particular, subperiosteal hemorrhages, result in alteration of the periosteum, its separation, or even the tearing off of fragments of it. The degenerated periosteum produces bony tissue which later fuses with the femur. This is a question of periosteal ossification of a traumatic origin. Ollier's theory is that the ruptured periosteum takes with it the embryonal cells of the young osteoblasts which quickly produce bone in the surrounding infiltration, so that it is fairly difficult to judge whether it is a post-traumatic ossification or perhaps a torn-off fragment of bone.

Pellegrini in his first paper on the nature of the concomitant shadow rejects the idea of a fracture of the bone in favor of a metaplasia of the connective tissue. In 1927 he expanded the first hypothesis by admitting that there could be various causes for the post-traumatic ossification, the most important of which might be the proliferation of the periosteum and metaplasia of the ligaments. According to Pfister, the concomitant shadow was the result of parosteal ossification, and he suggested for all similar structures the general designation of "callus without fracture," which means ossification of the periparosteal tissue resulting from a blow.

Others, such as Finochietto, Fiorentini (5), Bistolfi, Petrignani (11), and Mutel, Girand, and Branche, believe a hematoma should be considered as the cause of the concomitant shadow, the latter being a favorable site for the deposit of lime salts.

Temler (15), on the other hand, gives the following explanation: The form and position of the concomitant shadow exactly correspond to the intermuscular space between the adductor magnus and the vastus internus. The conditions for the resorption of the hematoma in this region are unfavorable, and he thinks that there results a calcification of small hematomas in consequence of capillary hemorrhages. This explanation seems nearer the truth because the collateral network is

abundantly developed in the region of the knee joint, particularly on its internal aspect. Kulowski (7), considering his material histologically and surgically, compares the Pellegrini-Stieda disease to ossifying myositis and finds the same conditions of metaplastic hyperplasia of the tissues underlie each process. He argues most instructively against the rupture and against the periosteal origin of the concomitant shadow, having seen a recurrence at the same site two and a half months after operation. Kulowski explains this fact by the surgical trauma and precocious mobilization of the limb already sensitized to the production of bony tissue. He warns against all surgical intervention before the completion of the process of ossification. Kulowski's explanation agrees with Pellegrini's ideas on this question.

From the literature we glean three possibilities for the appearance of the concomitant shadow, as follows: Separation of a bony fragment, periosteal ossification, and calcification of the soft parts with subsequent ossification. Let us consider each of these in turn. It can only be a question of detachment if (1) the shadow be revealed by the radiograph immediately following injury, proof of which is lacking, except for the cases of Schaaning and Andreesen in which, as a matter of fact, such structures were not disclosed until from three to four weeks after the injury, and the actual time of their appearance remains unknown. (2) The shadow is generally shaped like a hook with sharp outlines and not typical of a rupture. Also in the radiograph the femoral condyle shows no change as regards the position of the shadow. Even in the cases operated on in which the bony lamella was removed, there was no indication of change in the femur or of roughness in its contours. It seems very difficult to suppose that separation of a fragment of varying form and dimensions would not result in alterations in the contour of the femur. (3) Against the question of fracture there is the fact that the concomitant shadow shows a tendency to grow, and to change in form, structure, and density. We cite a case from our practice. Two months after a contusion, in a radiograph of the elbow (Case 6), there could be seen a light shadow, regarded as a site for the deposit of lime salts. Another radiograph made one month later revealed at the place of the aforementioned shadow four isolated structures, round and oval, of bony consistency, separated from each other as well as from the bone by clear spaces. (4) The shadow may diminish in size and even disappear (Köhler, Draudt).

(5) The appearance of a shadow even immediately after a trauma is not absolute proof of a separation, because it could also be the result of an old bone lesion. For example, a radiograph of the talocrural joint taken the day after contusion showed a fracture of the fibula and a narrow shadow, sharply outlined, along the internal malleolus, separated from the bone by a clear space of from 3 to 4 mm., and regarded as a calcification of the soft parts. In questioning the patient we learned that five months before, while playing football, he received a blow in the region of the internal malleolus (Case 7).

Several authors admit the possibility of the incidence of the shadow following periosteal ossification; but in that event it would be necessary for it to be connected with the bone in one way or another. The free space, clearly outlined, between the shadow and the bone is an argument against the periosteum taking part in the structure of the shadow, to say nothing of the fact that periosteal separation is anatomically extremely rare.

That the concomitant shadow may be the result of calcification and ossification of the soft parts is confirmed by the following: The bilateral character of the shadows, their multiplicity, structure, shape, and position; by the free space between the shadow and the surface of the bone, and the deposit of lime salts seen simultaneously although more rarely in the region of the intercondylar tubercle. With technically irreproachable radiographs one can easily distinguish between

the process of calcification and that of ossification.

Here are, briefly, some histologic examples which confirm the possibility, under certain conditions, of the transformation of the soft parts into bony tissue. In the case cited by Schüller-Weil there is noted an intratendinous metaplastic ossification where the formation of bone has taken place in part directly, and in part by metaplasia of the cartilage. A case of Fiorentini (5) shows all the phases in the histologic picture of metaplasia from the cartilaginous stage to the mature osteoid tissue. Fiorentini believes that this is a question of post-traumatic hemorrhage in which the resorption took the form of young connective tissues, degenerating finally into osteoid tissue. Histologic examination of Kulowski's case shows three principal stages in the development of the bone: Infiltration of the connective tissue, the formation of a callus, finally, more rarely, enchondromatous ossification.

Study of the histologic specimens argues against fracture and proliferation of the periosteum, but in favor of metaplasia of the tissues. This fact is admitted at the present time by the majority of authors and confirmed also by our own observations.

Bearing in mind the above, one question presents itself: Is it correct to speak of the Köhler-Pellegrini-Stieda disease? Our reply can only be in the negative, because, in reality, it is not at all a question of a "disease," but a local ossification process, the final result of a post-traumatic alteration. Its mechanism is identical with that of calcification in other tissues, such as the pleura, pericardium, pancreas, etc. As to designating this structure by the name of a writer, there is the question of whether it pertains exclusively to the knee joint. As we have just seen, similar shadows are found as well in other joints (leg, shoulder, elbow) exposed to injury. In addition, the so-called Köhler-Pellegrini-Stieda disease is nothing more than a calcification or ossification of the region of the knee joint, showing no consistent uniformity in clinical history for such classification, but forming a part of the general conception of post-traumatic, para-articular ossification.

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THE HEALING OF CAVITIES IN PULMONARY TUBERCULOSIS: ROENTGENOGRAPHICALLY OBSERVED[1]

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ROENTGENOLOGY has a right to be proud of the part it has played in developing the modern treatment of pulmonary tuberculosis. The memory of most of us extends back to the time when clinicians scouted our timorous suggestion that we could offer valuable aid in diagnosing tuberculosis and following the progression or retrogression of its tissue changes. To-day, we have difficulty in keeping pace with the claims of this same group regarding the important place of our art in clinical medicine. It is a clinician, and not a roentgenologist, who is responsible for the assertion that activity in the tuberculous lung cannot be detected by the stethoscope so positively as it can be shown by the x-ray film. It is a clinician, and not a roentgenologist, who has stated that we must depend on the x-ray appearances, rather than on physical signs or symptoms, to indicate when a lung lesion is healed. It is a clinician who asserts that only 60 per cent of cavities are found by physical examination, while 95 per cent of them are shown by x-ray examination. We modestly agree to these statements, at the same time calling attention to the fact that they are not the claims of over-enthusiastic x-ray specialists, but the matured confessions of eminent clinicians who are experienced in the observation and treatment of tuberculosis.

Graeff's statement, in 1921, that development of a lung cavity is a death sentence for the unfortunate tuberculous patient, marked off a new epoch in the treatment of the disease. Not all workers are in entire agreement with this gloomy prognosis, but, in spite of numerous exceptions, the majority of critical observers accept it as substantially correct—Pinner, Fischel, Barnes and Barnes, and Sprungman, among others. There are, of course, many kinds of cavities, of various sizes and locations in the lung-field, and such a general statement as that by Graeff naturally is subject to many exceptions. However, so universally is it now accepted that the modern phthisiologist adopts as the basis for the treatment of lung tuberculosis that "the cavity must be closed," and persistently follows the indicated course to bring this about, whether that course be medical or surgical.

Avoiding statistical data and clinical reports, this paper aims to present the subject by a series of cases of increasing complexity and difficulty, in order to illustrate how the problems of cavity formation are met and solved. Particularly does this presentation aim to illustrate the necessity for close co-operation among clinicians, surgeons, and roentgenologists in solving the problems of diagnosis and

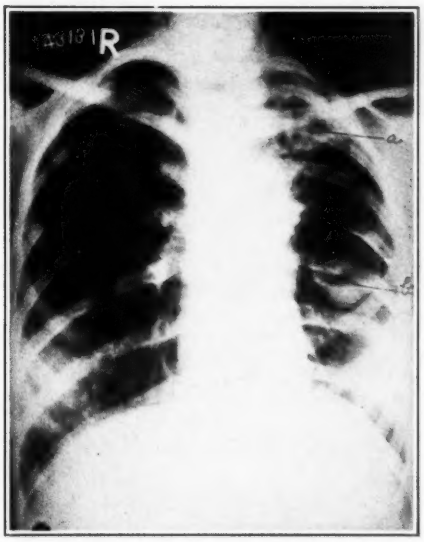

Fig. 1. Case I. Roentgenogram (Nov. 30, 1929) showing two cavities on the left side, one at apex (*a*), and the other 4 cm. in diameter just below hilus level (*b*).

[1] Presented before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

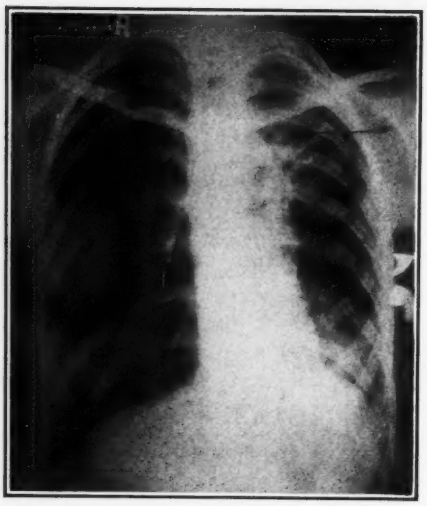

Fig. 2. Case I. Roentgenogram (Sept. 5, 1930) showing complete disappearance of the cavity near hilus, under simple bed rest.

Fig. 3. Case II. Roentgenogram (Dec. 1, 1928) showing large cavity below left hilus (*a*) close to heart border, with some infiltration in lower right lung-field

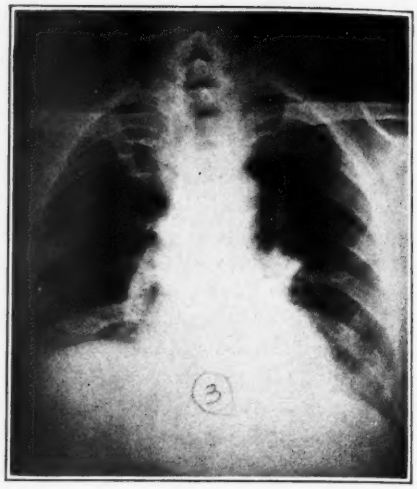

Fig. 4. Case II. After four months' postural rest, cavity in lower left lung-field has disappeared.

treatment of lung cavities of tuberculous origin.

It must be remembered that, whatever the size and appearance of the cavity, it is the product of a single pathologic process in different stages. The structure of the cavity depends on the degree of fibrosis which indicates the stage of its developmental cycle. "The interplay of caseation, liquefaction, resorption, and fibrosis, with the mechanical conditions within the lung parenchyma, accounts for the structural differences of cavities at given times in their development" (Pinner). Such changes can best be followed by serial x-ray examinations, and the structural changes shown by roentgenograms are more important than location or size of cavities, as indications for treatment.

During the clinical management of tuberculosis, the development of cavitation represents an emergency calling for special treatment. A tuberculous patient who develops a cavity as large as an inch in diameter has an average life expectancy under ordinary treatment of only a year (Barnes and Barnes). Some live longer, but the hope for permanent arrest or cure of the disease depends on the closure of the cavity, since it cannot heal until its walls are brought in contact and thus held long enough for scar tissue to form. To secure closure of the cavity and its final healing may tax the patience and ingenuity of the physician and surgeon, and call for the utmost in faithful

co-operation by the patient, in one method after another, until final success is achieved. Probably one-half of the cavities found in patients coming to physicians qualified to treat tuberculosis can be healed by simple or modified bed rest. Another one-fourth can be closed by pneumothorax. The remaining one-fourth will require the assistance of a chest surgeon for such procedures as phrenicectomy, intrapleural and extrapleural pneumolysis, and thoracoplasty. The special point to be kept firmly in mind from the outset is that the closure of the cavity is the aim of the treatment, since any method which will bring this about will also heal the exudative inflammation. The final success of the treatment will depend on the healing of the cavity and its replacement by scar tissue, as shown by the roentgenographic examination.

When cavities first develop, or when a patient first comes under the observation of the physician, the simplest methods are instituted unless it is obvious, from the history of the case, or the nature of the lesions, that such measures are doomed to failure. In determining this point, the x-ray findings assume a dominant place, and the interpretation of the roentgenologist on the basis of tissue pathology becomes supremely important. While under treatment, the cavity should be observed at frequent intervals by x-ray examination, as this is the only certain means of determining whether it is enlarging or healing. It is essential that this shall not be neglected, because simple methods must not be persisted in if they are not succeeding. The cavity must be closed, and if it becomes evident that a simple bed rest regimen will not be successful, more radical measures must be adopted. The measures ordinarily used for bringing about the closure of cavities are: (1) Simple bed rest; (2) postural bed rest; (3) bed rest with weights on chest; (4) phrenicectomy; (5) pneumothorax, unilateral or bilateral; (6) pneumothorax with intrapleural pneumolysis, unilateral or bilateral; (7) extrapleural pneumolysis; (8) thoracoplasty, (9) combinations of two or more of these.

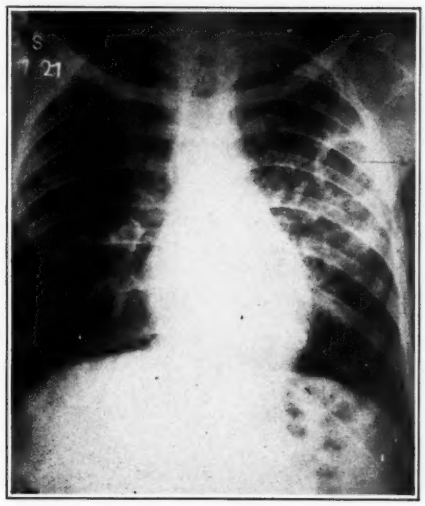

Fig. 5. Case III. Roentgenogram (October, 1927) showing large cavity in upper left lung-field (*a*), with surrounding exudative density.

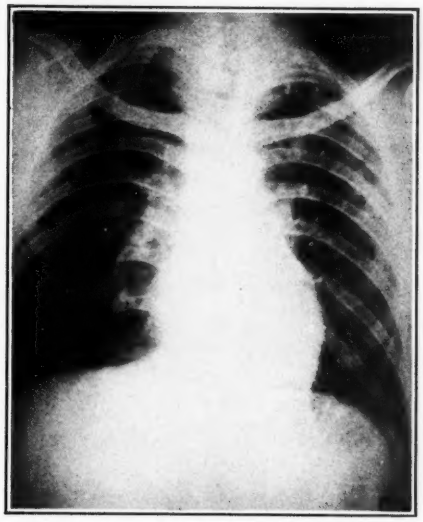

Fig. 6. Case III. Roentgenogram showing cavity closure after seven months' rest in bed with ten-pound shot bag over cavity.

Bed rest is the oldest and basic method of treating tuberculosis and is also the most efficient in closing certain types of cavities. Even large cavities will often heal with simple bed rest, especially if

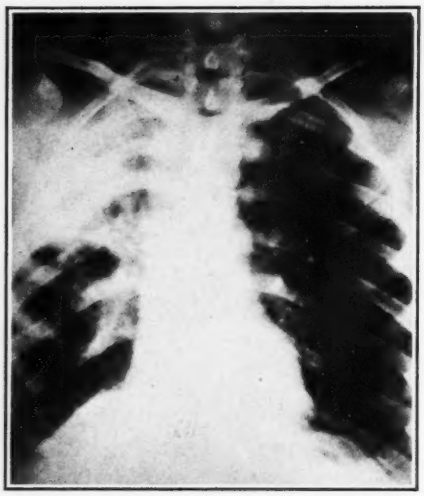

Fig. 7. Case IV. Condition on June 14, 1929, with extensive coalescing densities and cavitation in upper right lung, showing exudative lesions along heart border as low as diaphragm.

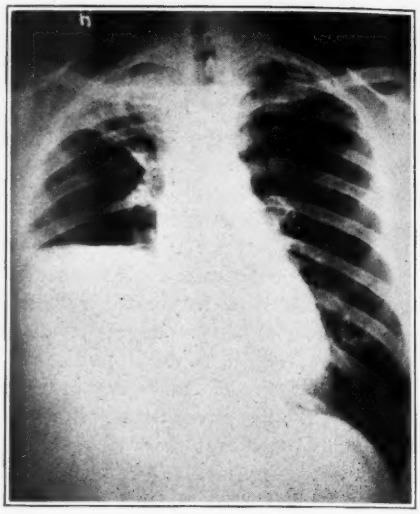

Fig. 9. Case IV. Condition in October, 1930, with closure of cavity in the upper lobe.

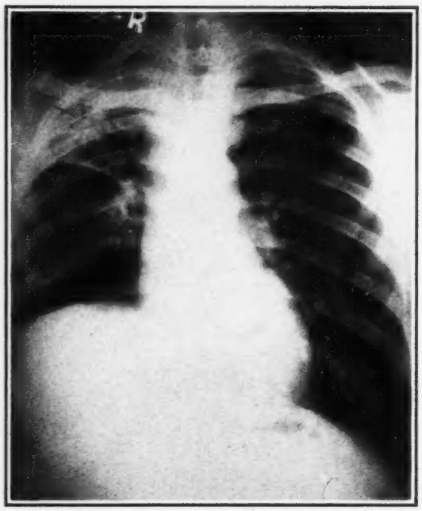

Fig. 8. Case IV. Condition on Dec. 10, 1929, after phrenicectomy on the right. Much of the exudative type of density has disappeared, and cavity has decreased noticeably in size (*c*).

recent and centrally located (Fig. 1). The localization of the cavity and the evaluation of the surrounding lung involvement by stereoroentgenograms will frequently indicate whether the cavity is likely to heal with bed rest alone, or whether such a regimen is doomed to fail, thereby justifying the clinician in proceeding immediately to more radical treatment. The importance of bed rest is not minimized by this relatively brief discussion. It remains the most important factor in treating any tuberculous lesion and, as stated, 50 per cent of cavities will heal under rest alone, when this is consistently and persistently carried out.

When simple rest in bed, rigidly enforced, is not efficient, it may be supplemented by postural rest. Under this régime the patient lies, over long periods, in that position which will diminish the size of the cavity and limit the respiratory motion of the surrounding lung. Like simple rest, it is most beneficial when the lesions are recent and the cavity walls subject to collapse.

A still further modification of rest is to lessen the chest motion over a limited area by means of weights, usually canvas bags of shot. When the cavity is in the upper lung-field, or is apical, and especially when there are bilateral cavities, this simple method is worthy of trial. Bags up to ten pounds in weight are readily borne and patients soon become accus-

tomed to them and sleep with the bags in place. (In one case reported by Dr. Holmes a shot bag weighing 27 pounds was used with good results.)

Many cases of cavity healing under simple or modified bed rest could be cited, but three illustrative ones will suffice.

Case I. A roentgenogram of Nov. 30, 1929 (Fig. 1), shows two cavities on the left side, one at the apex (*a*), and the other (4 cm. in diameter) just below the hilus level (*b*). On bed rest alone, by September, 1930, the large cavity at the hilus level had entirely healed (Fig. 2), although the one at the apex had not yet closed. This illustrates the relative ease with which healing of a centrally located cavity may be secured, as compared with one located at the lung surface over which pleural adhesions quickly form.

Case II. A roentgenogram of Dec. 1, 1928 (Fig. 3), shows a large cavity below the left hilus (*a*), close to the heart border, with some infiltration in the lower right lung-field. This patient was placed on postural rest and in four months, as shown by Figure 4, the cavity in the left lung-field entirely disappeared. Note also the shortening of the chest cavity because of the patient's gain in weight and the consequent lifting of the diaphragm.

Case III. A roentgenogram made in October, 1927 (Fig. 5), shows a large cavity in the upper left lung-field, with a surrounding inflammatory infiltration. Under seven months' rest in bed with a ten-pound shot bag over the cavity, the lesion and its surrounding inflammatory zone entirely disappeared (Fig. 6).

Phrenicectomy.—While paralysis of one leaf of the diaphragm, by removal of a section of the phrenic nerve, the so-called phrenicectomy, is a procedure of comparatively recent application in the treatment of lung cavities, and is classed as a surgical method, it is mentioned next in order to preserve the arrangement of increasing complexity. It is a very simple means of treatment and will sometimes be efficient when bed rest, simple or modified, and pneumothorax have failed. It is the most economical of all methods of obtaining rest for the diseased lung. Unfortunately, it is applicable to a selected group only, but within that group has proven very satisfactory. The elevation and paralysis of one leaf of the diaphragm mechanically displaces the underlying abdominal organs and sometimes causes unpleasant symptoms. Two illustrative cases are cited.

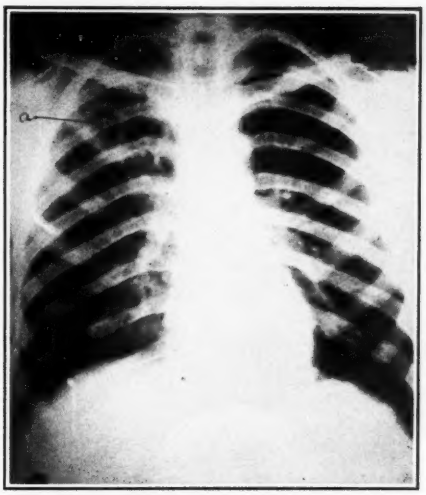

Fig. 10. Case V. Roentgenogram (October, 1929) showing involvement in upper right lobe, with cavity formation (*a*).

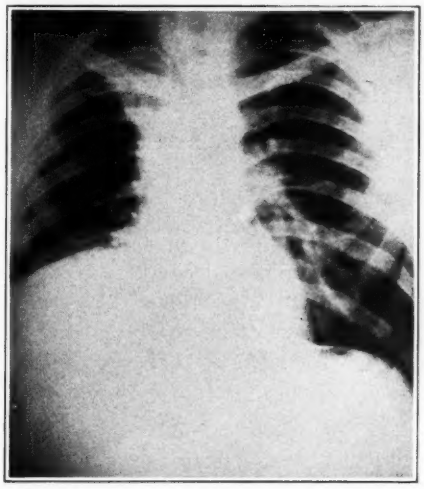

Fig. 11. Case V. Cavity healed, following phrenicectomy.

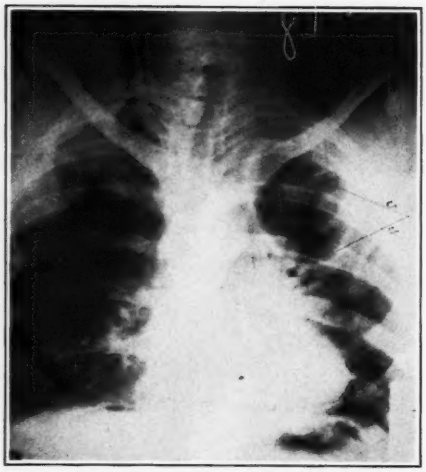

Fig. 12. Case VI. Roentgenogram (June 23, 1928) showing huge cavity involving almost entire upper left lung-field (*c, c*).

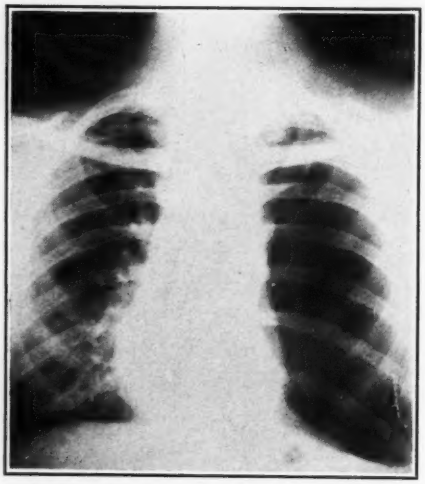

Fig. 13. Case VI. Roentgenogram (Oct. 15, 1931) made nearly two years after establishment of pneumothorax on the left side.

Case IV. A roentgenogram made on June 14, 1929 (Fig. 7), shows extensive coalescing densities and cavitation in the upper right lobe, with exudative lesions along the heart border as far as the diaphragm. Phrenicectomy was done and the roentgenogram of December, 1929 (Fig. 8), shows marked improvement. Note the height of the immobile diaphragm and disappearance of much of the exudative shadow. The cavity has diminished in size. Ten months later, in October, 1930, a roentgenogram (Fig. 9) showed disappearance of all basal densities, closure and healing of the upper right lobe cavity, and change from the exudative to the fibrotic type of shadow. The higher position of the diaphragm is due to the patient's gain in weight.

Case V. A roentgenogram made in October, 1929 (Fig. 10), shows upper right lobe involvement, with cavity formation, the left lung being free from significant shadow. Phrenicectomy was done, followed by complete closure and healing of the cavity, as shown by the film made in October, 1931 (Fig. 11).

Artificial Pneumothorax (Unilateral).—Undoubtedly the oldest, most popular, and widely used procedure specifically directed toward the closure of cavities is artificial pneumothorax. It is a simple method, offering a maximum of success with a minimum of danger. So many papers have been written on this subject that it is thoroughly familiar to all of us. As simple as the method is, it still requires good judgment, careful technic, and the most sympathetic co-operation between patient and physician, as well as frequent roentgenologic study. Not too long a time should be consumed in trying simpler methods, if it is at all likely that pneumothorax may have to be used, because there is an ever-increasing danger that adhesions will form and prevent the compression, especially when the cavity lies close to the pleural surface. Either phrenicectomy or intrapleural pneumolysis can often be used as an adjunct to pneumothorax, in order to secure more perfect closure of the cavity. One typical case, from many that could be cited, will suffice for illustration.

Case VI. A roentgenogram taken in June, 1928 (Fig. 12), shows a huge cavity involving almost the entire upper left lobe. This was placed under pneumothorax, the lung fortunately being found free from adhesions. The roentgenogram of October,

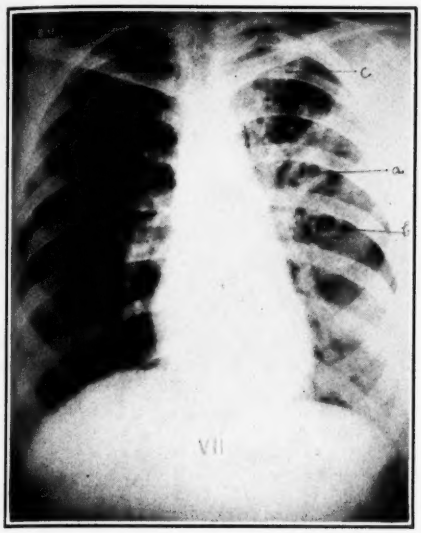

Fig. 14. Case VII. Roentgenogram (April 25, 1929) showing cavities (*a*), (*b*), and (*c*), with exudative densities through upper left lung-field.

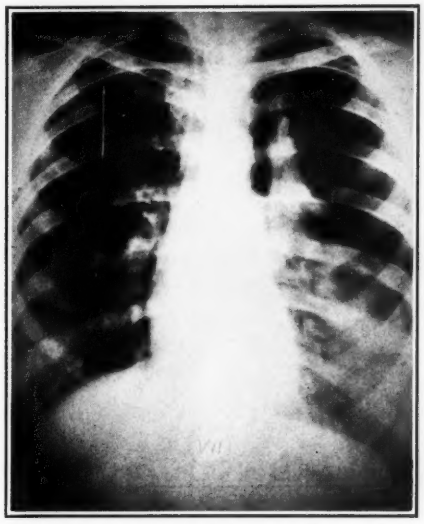

Fig. 15. Case VII. Selective collapse of the upper left lobe closing the cavities and with the lower lobe expanded and functioning.

1931 (Fig. 13), shows the lung still being held under compression over two years later. The large cavity is entirely closed, the air pressure being sufficient to cause slight displacement of the heart to the right. This patient, a physician, returned to his Eastern practice with the lung still compressed, and was still keeping it so when information was last received from him.

Bilateral Pneumothorax.—In cases of bilateral cavitation, or in the event of cavitation developing in the functioning lung after pneumothorax has been established on the opposite side, the situation can frequently be handled with bilateral pneumothorax, or simultaneous compression of both lungs sufficiently to close the cavities. This seemingly radical treatment is astonishingly well borne. The functioning lung tissue can be reduced to a fraction of that ordinarily used, without great inconvenience, providing this is done gradually. On the Continent bilateral pneumothorax is quite extensively employed and is rapidly coming into favor in this country. Needless to say, frequent x-ray observations are essential in order to carry on this procedure accurately. I cite one illustrative case.

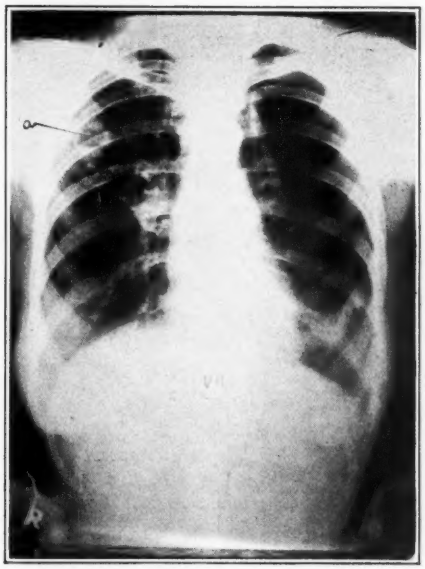

Fig. 16. Case VII. Roentgenogram (April 22, 1931) showing distinct cavitation in the right lung (*a*), and satisfactory collapse still maintained on the left side.

Case VII. A roentgenogram of April, 1929 (Fig. 14), shows multiple cavities

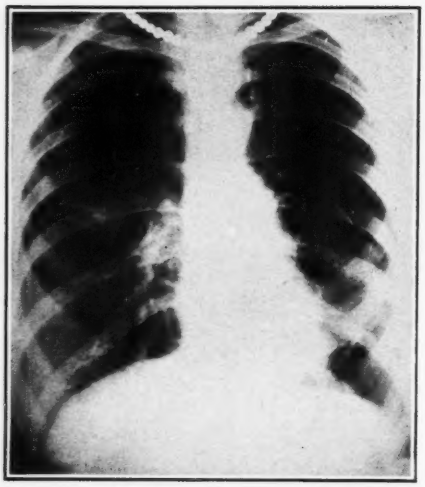

Fig. 17. Case VII. Roentgenogram (March 23, 1932) showing bilateral pneumothorax, with selective collapse closing cavities in each upper lobe, and with lower lobe of each side functioning.

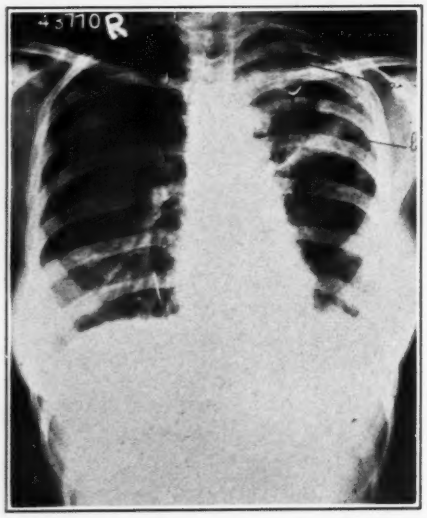

Fig. 18. Case VIII. Roentgenogram (Jan. 13, 1928) showing fairly extensive involvement of the upper left lung-field, with multiple small cavities (*a*), (*b*).

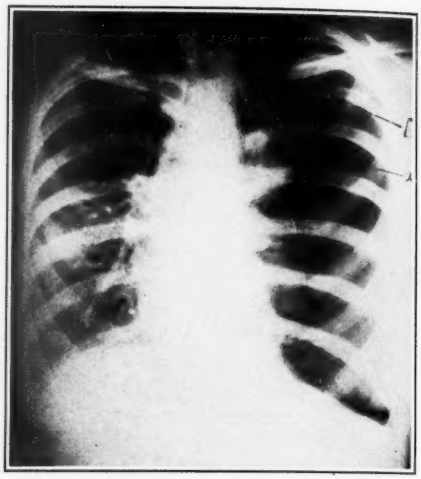

Fig. 19. Case VIII. Showing extent of collapse, by pneumothorax, incomplete on account of adhesions (*b*).

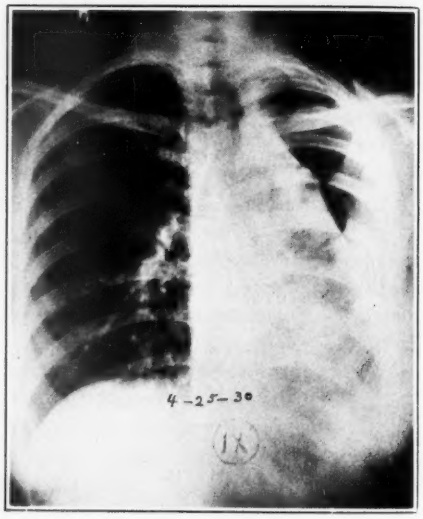

Fig. 20. Case VIII. Showing conditions after intrapleural pneumolysis.

(*a*), (*b*), (*c*), with exudative shadow through the left lung. The right lung was free from abnormal shadow. The left lung was placed at rest by pneumothorax, the condition in March, 1930, being shown by the roentgenogram seen in Figure 15, with upper lobe cavities closed and the lower left lobe expanded and functioning. In April, 1931, the patient returned from a summer spent in the East, during which time no x-ray observations had been made, with conditions as shown in Figure 16. The left lung was still held under compression closure, but definite involvement and cavity had developed in the upper right

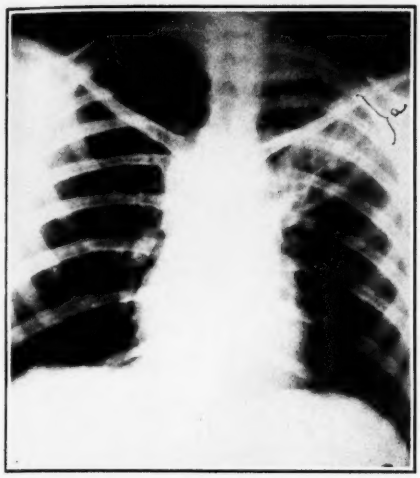

Fig. 21. Case IX. Roentgenogram (February, 1930) showing large cavity in the upper left lobe (*a*), with surrounding infiltration.

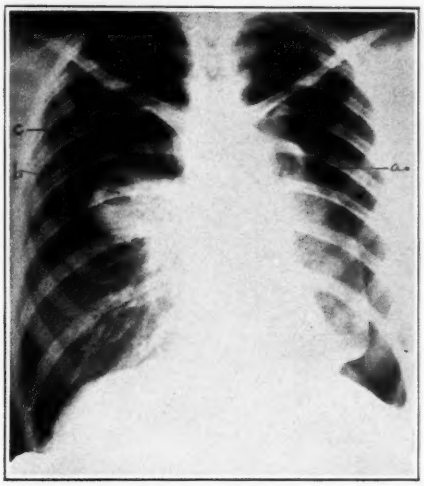

Fig. 23. Case IX. Condition after intrapleural pneumolysis had freed the adhesions on the left, and pneumothorax had been instituted on the right.

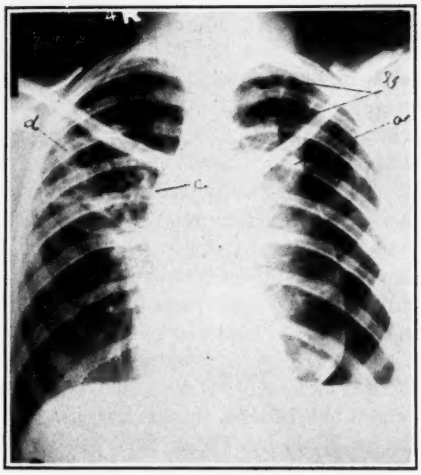

Fig. 22. Case IX. Showing incomplete closure of cavity on the left and extension of the process on the right.

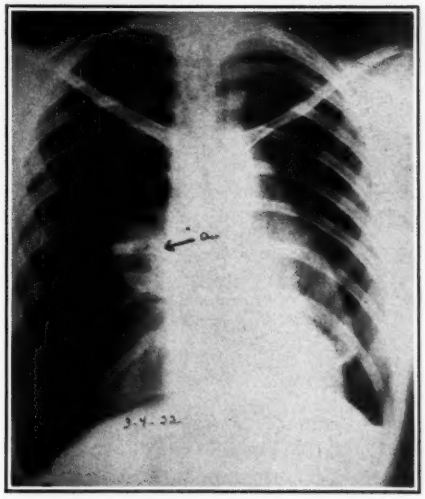

Fig. 24. Case IX. Condition on March 4, 1932. Cavity has been closed on the left. The adhesion on the right has been freed by intrapleural pneumolysis, and this cavity has almost entirely closed (*a*).

lung. The right lung was now compressed, and in March, 1932 (Fig. 17), cavities were being held closed by selective compression on each side. After about a year of this treatment, both lungs were allowed to re-expand, and the cavities remained closed, with the patient in good health.

Intrapleural Pneumolysis.—The attempt to close cavities by pneumothorax frequently fails because adhesions to the chest wall prevent satisfactory compression of the cavity. In suitable cases, these adhesions can be burned through by the method of Jacobæus, or intrapleural pneumolysis. It may be remarked, in passing, that this procedure is little more

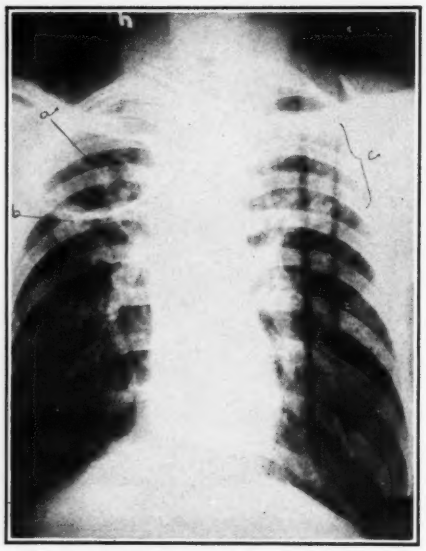

Fig. 25. Case X. Condition of lungs in March, 1931, with very large cavity in upper right lung-field (*a*).

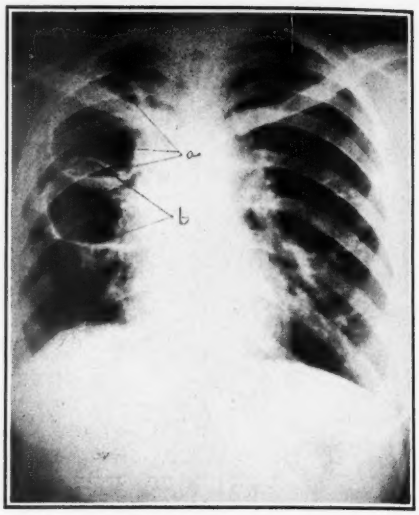

Fig. 27. Case XI. Roentgenogram (June, 1930) showing very large double cavity (*a*), (*b*), occupying most of upper two-thirds of right lung.

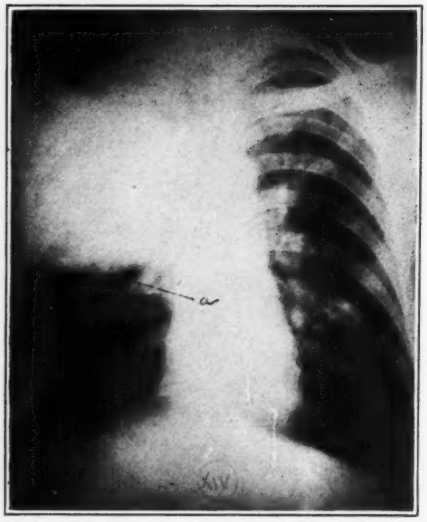

Fig. 26. Case X. Condition after obliteration of cavity by extrapleural penumolysis (paraffin filling).

than a modification of peritoneoscopy, developed by Orndoff in this country. The instruments used are quite similar to the peritoneoscope of Orndoff, with the addition of a cutting or cautery knife. No procedure in the chest requires closer cooperation between surgeon and roentgenologist, nor more critical interpretation of roentgenographic and fluoroscopic findings. Just where the adhesion bands are attached, their relation to underlying lung tissue, whether they incorporate air-containing lung or are entirely fibrous, are some of the vital questions which the roentgenologist must aid in solving.

Case VIII. A roentgenogram of January, 1928 (Fig. 18), shows fairly extensive involvement of the upper left lung-field, with multiple cavities (*a*), (*b*). This lung-field was placed under pneumothorax compression, which did not succeed in closing the cavities on account of adhesions. Note in the roentgenogram of July, 1928, that the lung is compressed everywhere except at the desired points (Fig. 19). These adhesions were then freed by intrapleural pneumolysis, with satisfactory closure of the cavities and adjacent lung (Fig. 20), the basal portion of the lung remaining open and functioning (selective collapse).

Case IX. A roentgenogram of February, 1930 (Fig. 21), shows a large cavity

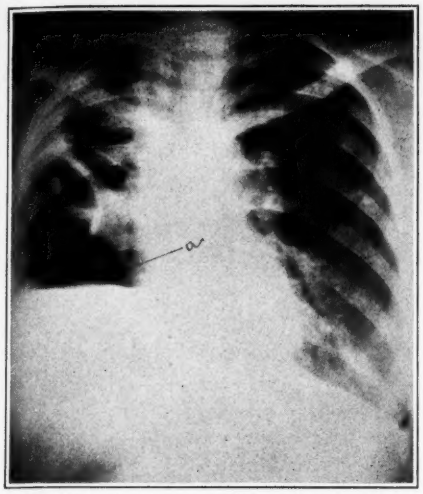

Fig. 28. Case XI. Condition after unsuccessful attempt to collapse the cavities by pneumothorax, supplemented by phrenicectomy.

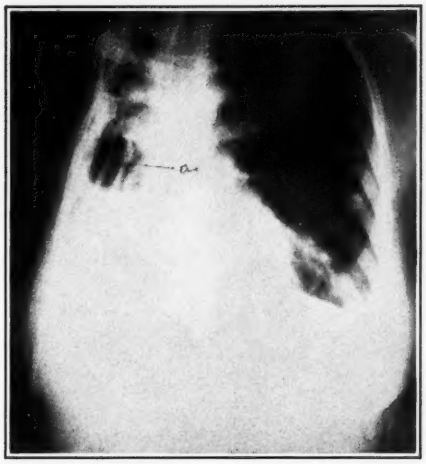

Fig. 29. Case XI. Condition in June, 1931, after second stage of thoracoplasty. Immobility of mediastinum resulted in incomplete closure of cavity (*a*). This has since been closed by paraffin filling.

in the upper left lung-field, with surrounding infiltration. This was placed under pneumothorax (Fig. 22), but the cavity was not entirely closed (*a*) on account of limiting adhesions. There was now observed also an extension of the disease in the right lung, with cavity formation (*d*). The adhesions were first freed by burning on the left side, resulting in almost complete closure of the cavity (*a*) (Fig. 23). Pneumothorax was instituted on the right side, but the cavity (*b*) was held open by adhesive bands (*c*). After the adhesive bands had been freed on the right, a roentgenogram of March, 1932 (Fig. 24), showed the cavity on the left to be closed, and the one on the right almost obliterated. Note how little functioning lung tissue is required to maintain comfort. This patient is ambulant and can climb stairs without dyspnea.

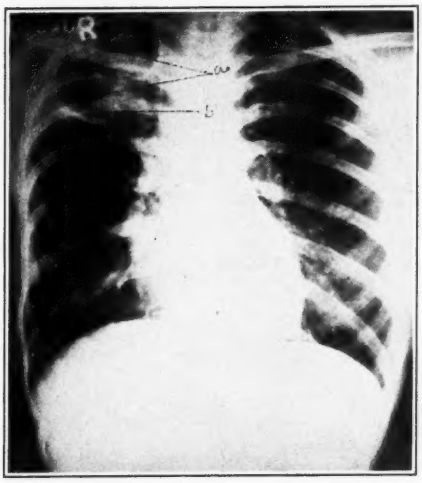

Fig. 30. Case XII. Roentgenogram (March, 1929) showing large cavities in upper lobe of right side (*a*).

Extrapleural Pneumolysis.—In an occasional case in which there are large apical cavities and pneumothorax cannot be established on account of adherent pleural surfaces, extrapleural pressure can be used to bring the cavity walls into apposition. The use of paraffin wax is one method which, while it has many drawbacks and a limited application, on the occasional case permits one to avoid doing a thoracoplasty.

Case X. A roentgenogram of March, 1931 (Fig. 25), shows a very large cavity in the upper right lung-field (*a*), with surrounding infiltration, and some exudative involvement in the upper left lobe. Pneumothorax was tried and failed on account of an adherent pleura. The cavity was

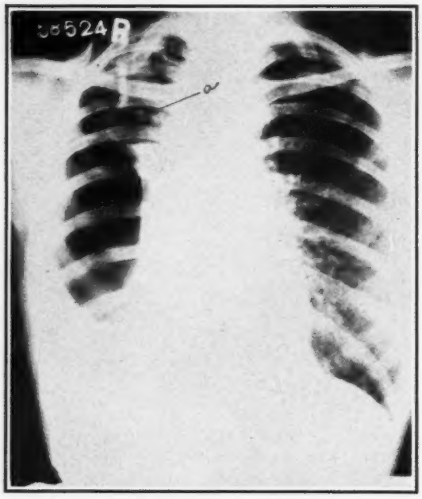

Fig. 31. Case XII. Condition after collapse by pneumothorax, which was not successful in closing the apical cavity (*a*).

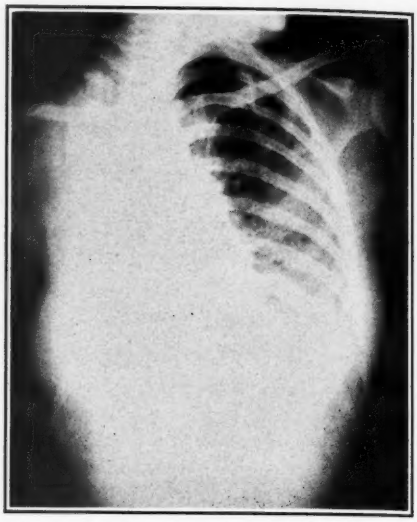

Fig. 33. Case XII. Condition (November, 1931) after thoracoplasty, showing hemithorax obliterated and cavities closed.

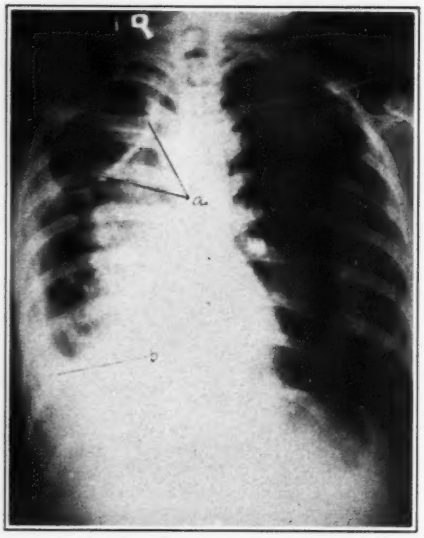

Fig. 32. Case XII. Condition after lung had expanded. Cavity still present (*a*), larger than before.

compressed by extrapleural paraffin wax injection (Fig. 26).

Thoracoplasty.—This is the best known of radical surgical procedures for closing lung cavities. In times past, it has been looked upon as a desperate last resort, but should not be so regarded. It will frequently succeed after the entire gamut of bed rest, postural rest, shot bags, pneumothorax, phrenicectomy, and pneumolysis has been tried and failed. Attempt should be made to evaluate the prospects of these methods and save the patient a long series of discouraging experiences, when it is evident that nothing except complete obliteration of the hemithorax can possibly succeed in restoring him to a useful state of health. The judicious clinician will not delay too long in seeking counsel of roentgenologist and surgeon, for determining whether or not simpler methods hold out any hope of success.

Case XI. The roentgenogram made in June, 1930 (Fig. 27), showed a very large double cavity occupying most of the upper two-thirds of the right lung. An attempt to close this double cavity by pneumothorax, supplemented by phrenicectomy, was made (Fig. 28), and failed. Thoracoplasty was then performed (Fig. 29). Immobility of the mediastinum prevented complete obliteration of the lung space on the involved side, leaving the cavity partly open. Later this was closed by extrapleural paraffin filling.

Case XII. A roentgenogram made in

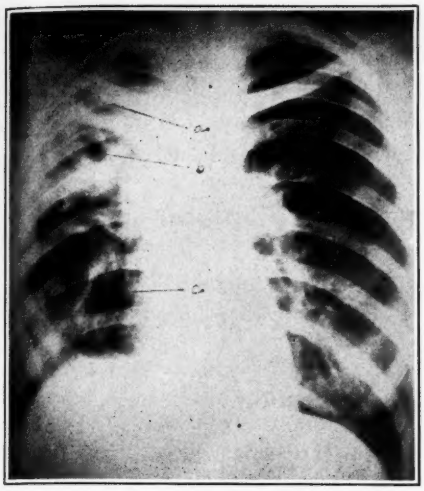

Fig. 34. Case XIII. Roentgenogram (February, 1929) showing extensive cavitation and much surrounding exudative density through lung-field on the right. Cavities at (*a*), (*b*), and (*c*).

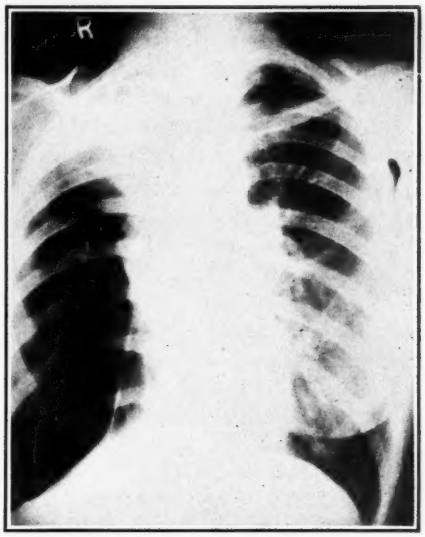

Fig. 35. Case XIII. Roentgenogram showing failure of adequate compression of involved upper lobe, on account of dense adhesions.

March, 1929, showed large cavities in the upper right lobe (Fig. 30). An attempt to close these by pneumothorax was made, but broad bands of adhesions prevented (Fig. 31). Such adhesions as these cannot be severed by burning. The lung was allowed to expand, the cavity being larger than before (Fig. 32), with atelectatic tissue in the base, resulting in displacement of the heart to the right. This lung space was obliterated by thoracoplasty, with restoration of the patient to working capacity (Fig. 33).

Case XIII. This patient showed such extensive lung destruction on the right (Fig. 34) that nothing except total obliteration of the right chest cavity could hold out any hope for success. However, pneumothorax was tried (Fig. 35), but adhesions showed the futility of this, and thoracoplasty was finally performed, with restoration of the patient to health (Fig. 36).

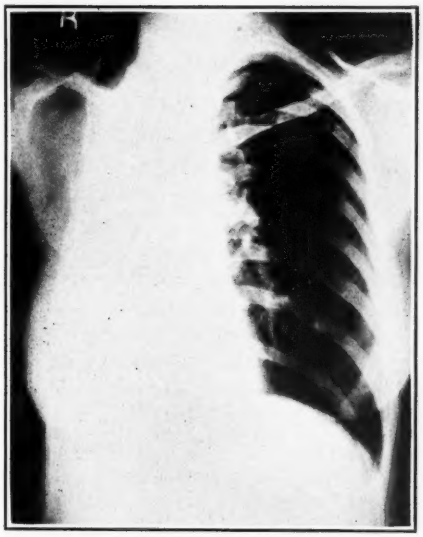

Fig. 36. Case XIII. Condition after closure of cavities by thoracoplasty.

These thirteen illustrative cases are shown mainly to demonstrate the value of roentgenologic observations, as the tuberculous patient travels the road, frequently long and hard, to the cure of his disease and a return to the normal activities of life. A peculiar characteristic of the disease is the hopeful outlook which is almost universal with these patients. The combined judgment of more than one advisor in avoiding pitfalls and choosing right methods will be required if this hope is to

be realized. Happy is the patient whose course along this path is guided by the co-operative thinking of a tactful, sympathetic, and intelligent physician, a skillful and courageous surgeon, and a well-trained and competent roentgenologist.

The cases used as illustrations in this paper are from the private practices of Dr. F. G. Holmes, Dr. H. S. Randolph, and Dr. V. S. Randolph, of Phoenix, Ariz., to whose courtesy the writer is indebted for clinical notes and data.

A NEW ADAPTATION FOR CARDIAC MEASUREMENT OF THE FRONTAL SILHOUETTE[1]

By MAURICE RONA, M.D., *New Brunswick, N. J., and* WILLIAM G. HERRMAN, M.D., F.A.C.P., *Asbury Park, N. J.*

A NEW METHOD OF MENSURATION OF THE POSTERO-ANTERIOR HEART: A COMPARATIVE STUDY

WHETHER or not mensuration is justifiable at all is still a much argued question, dividing the roentgenologists into opposing camps, with the cardiologists mostly joining the opposition. Those who practise mensuration say that the diagnosis of heart diseases has been made from measurements and proved against the skepticism of the clinician by electrocardiography, time, and autopsy. Those who condemn the idea have nothing but scornful disdain for "mathematics in x-ray," and maintain that only the size, shape, and relation of the heart to adjacent organs comprise radiology's contribution to the study of heart disease. When we find such diametrically opposing views, we have to study the problem from the ground up.

Review of the Literature.—A review of the literature shows that the idea of mensuration is gaining strength. The text-books of Assmann (1), Schinz (2), Holmes and Ruggles (3), and Kerley (5) give figures for the transverse diameter, the area of the P-A silhouette, and the methods for estimating the volume of the heart. Others, who compared the cardiac transverse diameter with the transverse diameter of the chest, cardio-thoracic ratio, and with the length diameter of the heart, are as follows: Dann (6); Fossier (7); Pendergrass (8); Chandlee and Burvill-Holmes (9); Miller and Gershon-Cohen (10); Dann (11); Steel (12), and White and Camp (13). Hodges (18), Hodges and Eyster (14), and Bedford (19) correlated the transverse diameter of the heart and the frontal area with the height, weight, and age of the person. Also they worked out, on a purely mathematical basis, prediction formulas. All of these workers take only one diameter into account, but as the material has gathered, it becomes more and more evident that the transverse diameter is not a reliable guide to the diagnosis of the pathologic conditions. The frontal area, on the other hand, is rather difficult to measure because it gives rise to many errors. The main objection to these methods is that they do not give information about the individual chambers but consider the heart as a unit. However, this objection cannot be raised against the Vaquez-Bordet method (20), which gives measurements of the individual chambers and a table of the normal and pathologic averages. In this country, Levene and Reid (21) took up this method, which will be discussed more fully further on in this article, and made a rather thorough study of it.

Other investigators started out in another direction. Rigler (22, 24) relies on the fact that the left auricle is in close proximity to the esophagus, and an enlargement of the auricle must displace the esophagus. Therefore, he fills the esophagus with barium and takes films in the right lateral view, observing the curving and deviation of the barium column. Nichols and Ostrum (25) use the right oblique position. Neither Rigler nor Nichols and Ostrum use measurements.

Kane, Andrew, and Warren (26) struck out in still another direction. The study of mounted anatomic preparations showed them that, in the left oblique position, the interventricular septum is mid-way between the aorta and the pulmonary cone and can be marked with relative ease, making possible the separate measurement of the left and right ventricles.

Fray (27) further developed Kane's method, with some modifications. He

[1] Read before the Radiological Society of New Jersey, Feb. 10, 1934. Accepted for publication April 9, 1934.

pointed out that many times it is impossible to find the mid-point between the aorta and the pulmonary cone; therefore, it is necessary to devise another means of finding the septum. This he did by rotating the patient at 45° to the left, so that the distance of the spine to the right chest wall was twice as great as it was to the left chest wall. He then proceeded to find the septum: on the right lateral tracheal wall, immediately above the bifurcation, a point was marked, and its distance to the right chest wall measured; then this same distance was laid off to the left, projecting beyond and to the left of the spine. The number of millimeters thus projecting was added to the transverse chest diameter from the right chest wall to the spine, taken at the height of the ventricles. The entire width of this lower line was halved, and the half-point was connected with the tracheal point, giving the interventricular septum.

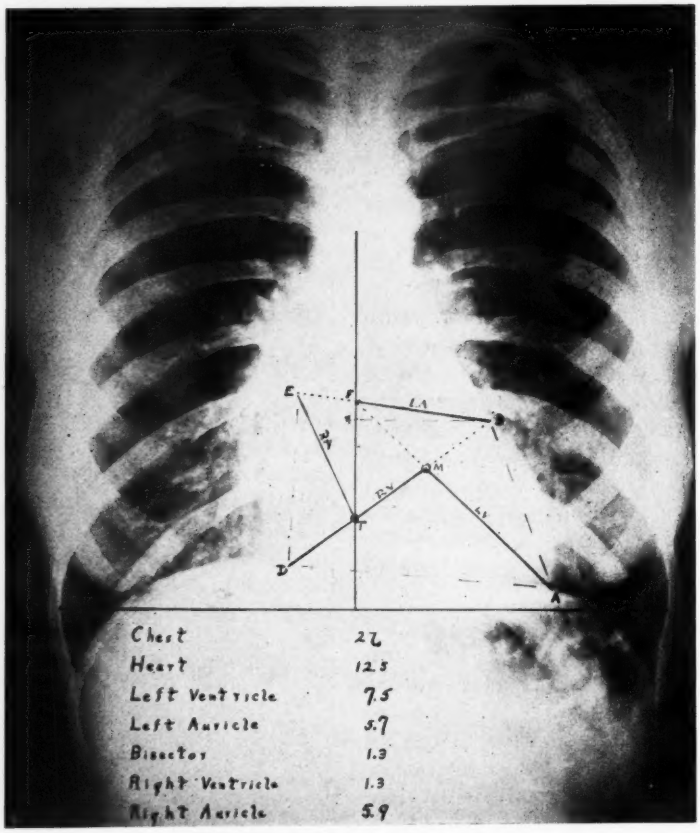

Fig. 1.

He found that in this particular rotation the transverse diameters of the normal ventricles are about equal, and that the total cardiac transverse is about one-half of the transverse diameter of the chest. This he used as a prediction formula and a check-up on the x-ray findings.

Nemet and Schwedel (29, 30) also use the left oblique for ascertaining whether or not the right ventricle is enlarged—they use no measurements. According to them, the interventricular groove is visible fluoro-

scopically and serves as a landmark for the right ventricle. They, after Frick, differentiate between enlargement of the inflow and outflow tract. The latter is recognized on the P-A film by the prominence of the pulmonary cone; the former on the left oblique film by the following: (1) prominence of the right lower cardiac border; (2) angulation of the anterior cardiac border; (3) broadening of the diaphragmatic heart outline; (4) displacement of the interventricular groove to the left and upward. It is interesting to note that the point of their interventricular groove does not coincide with the constructed septum of Fray.

We shall not discuss further the methods that measure only the length and width of the heart, as these give no information of the individual chambers. We believe it is obvious that if a method can give such information, it is superior to the less exact methods. The Vaquez-Bordet method (Fig. 1) takes the following measurements: *A-B* as the left ventricle; *D-A* as the right ventricle; *D-E* as the right auricle; *B-F* as the left auricle. Unquestionably all these chords bisect the respective chambers, yet their practical value is not always satisfactory because their direction is not coincident with the greatest enlargement of the chambers. For this reason the original figures of Vaquez and those of Levene show too great a variation and overlapping in health and disease. Fray's constructed septum and the anatomic septum are two different things. Therefore, the mensuration of the ventricles, based on this line, cannot be trustworthy.

These are some of the deficiencies in existing methods of radiographic cardiac mensuration that prompted us to search for a new way of attacking the problem, and to lay the diameters in a different fashion.

Our New Method.—Starting from textbook drawings and Le Wald's experiments, we took the atrio-ventricular ostia into account and, because they remain centrally located, no matter how large the chambers become or in what direction they grow, we fixed their position for a starting point in our measurements.

Our second consideration concerned the direction in which the individual chambers may grow in disease. We know that the left ventricle grows toward the apex, leftward and downward; the right ventricle may enlarge to the right and toward the diaphragm if the inflow tract is involved, upward and toward the pulmonary cone if the outflow tract dilates. The right auricle grows upward and toward the right. We speak of the left auricle last because it offers particular difficulties; it lies posteriorly and never shows on the *P-A* silhouette, and when enlarging it grows toward the right and backward. Therefore, any attempt to measure it on the *P-A* film seems to be futile, yet it can be measured indirectly as we shall show. The bulging on the left median border, so-called "mitral configuration," is caused by the enlargement of the outflow tract of the right ventricle. Therefore our "*L-A* diameter" measures the outflow tract of the right ventricle and not the left auricle. But we know that in mitral disease there is a compensatory enlargement of the right ventricle; the pulmonary cone becomes larger; the right ventricle forms part of the left border, and the left ventricle is pushed backward, thus having a lesser part in the left border formation. Consequently our point *B* (Fig. 1) moves downward and the diameter *B-F* lengthens, a consequence by which we can infer that an enlargement of the left auricle has taken place.

Technic of Our Method.—For the technic of constructing our diameters, we refer to Figure 1, which presupposes that the chest-cage is of normal shape and that the heart is normal in position and in normal rotation. *B* marks the left auriculo-ventricular, *E* the right auriculo-aortic, *D* the right auriculo-diaphragmatic point, and *A* the apex. *B-D* is the base-line which passes through both ostia. The tricuspid lies at the intersection of the base-line and the mid-line at *T*. We find the mitral opening in the following way: connect the left auriculo-ventricular point (*B*) with

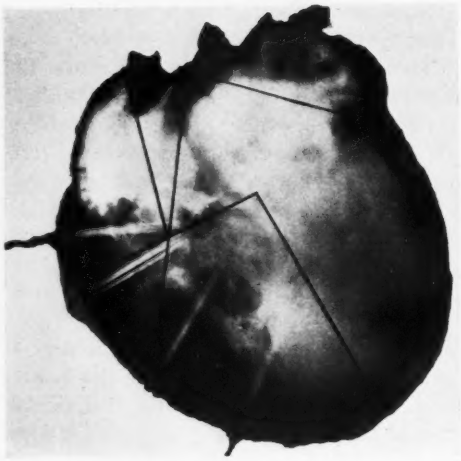

Fig. 2.

the right auriculo-aortic juncture (*E*) up to the mid-line (*F*); from here, that is, from the median end of the *L-A* chord, draw a connection to the apex, the intersection of these two lines thus locating the mitral valve (*M*). From the mitral valve to the apex *M-A*, we measure the left ventricle diameter; from the mitral opening to the right diaphragmatic point, the right ventricle (inflow tract). The distance between the tricuspid ostium and right auriculo-aortic juncture gives the right auricular diameter (*R-A*). We have previously mentioned the *L-A* chord and note that we called it the left auricular chord only for the sake of convention, but in reality it measures the outflow tract of the right ventricle.

In order to get any value at all from these measurements, it is necessary to fix the guiding points with the greatest care. If the positioning of the patient is accurate and there is no rotation, then the spinous processes and the trachea will fall in the mid-sternal line. The apex and the two auricular points are preferably observed and marked under the fluoroscope, when also note should be taken of whether or not the heart is normally or abnormally rotated. Abnormal rotation, naturally, excludes the possibility of reliable mensuration. The apex may be below or above the diaphragm and should be marked without regard to the diaphragm. The left auriculo-ventricular point may present considerable difficulties, but the following observation may help. The juncture of the left ventricle with the left auricular appendage, or with the right ventricle, is usually marked by a small notch—the sulcus between the auricular appendage and the ventricle, or the sulcus of the transverse coronary vessels between the ventricles. In the absence of the notch, the left auricular appendage may still be border-forming and we will be able to find it by remembering that the appendage does not pulsate, consequently its shadow-line appears sharper and unblurred, while that of the pulmonary cone and the left ventricle is fuzzy or double-lined. This observation about the relative sharpness of the outline may hold good only for the customary slower technic and may not be applicable in the ultra-fast exposures. In other cases, when the right ventricle is enlarged but the left one is not, the bulging line of the right ventricle at the left border will fall down in a straight line toward the apex. The validity of the foregoing theoretical considerations had to be tested and proved by autopsy findings and by clinical observation.

Autopsy Findings.—The first autopsy material came from a post-operative death of a subject with a normal heart. The heart was removed from the cadaver about twenty hours after death. We put the heart in a position approximating the normal as nearly as possible, then injected first one, then the other, auricle with sodium iodide solution and made exposures at a 6-foot distance. Figure 2 shows the chambers with the diameters drawn in, and also the fact that the diameters correspond very closely to their respective chambers. The second postmortem specimen was that of a man who had a syphilitic aortic lesion. X-rays had been taken of his heart during life. After making tracings *in situ*, we removed the heart and lungs together and fixed them in formalin. About six hours later, we injected both auricles with so-

dium iodide. Figure 3 shows the result, while Figure 4 is a composite picture of the film made in the living, and of the tracing of the injected heart superimposed on the film. You see that our diameters coincide with their respective chambers, and the image of the living and the formalin-fixed heart correspond to each other. Also, Figure 5 shows a case in which the post-mortem corroborated the roentgen diagnosis of ventricular enlargements. The tracing *in situ* is superimposed on the film. Figure 6 did not come to autopsy, but the sudden death of the man from coronary thrombosis clinched the diagnosis. In this case the customary mensuration methods do not show any pathology, while our method proves that there was an enlargement of both ventricles.

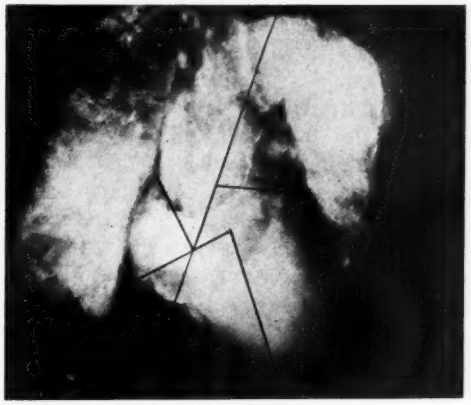

FIG 3.

Clinical Study.—For clinical proof, there were two ways open for us: One was to find illustrations in books or magazines in which the normality or pathology of the case was definitely known, and in which, some measurements being given, we could reconstruct the other measurements and make a reasonable comparison with our own diameters. Luckily, we found such illustrations in Holmes and Ruggles' book, and in Dann's and in Levene's articles. The following are the results of the comparison. Dann's normal heart, although larger than what we regard as normal, had normal proportions and diameters, although again the RV diameter appeared a

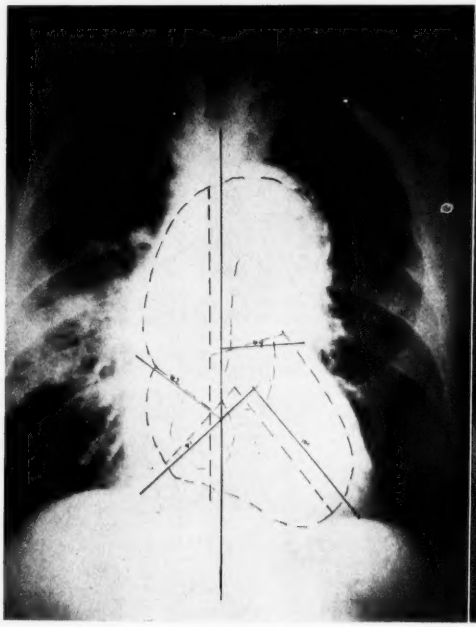

Fig. 4.

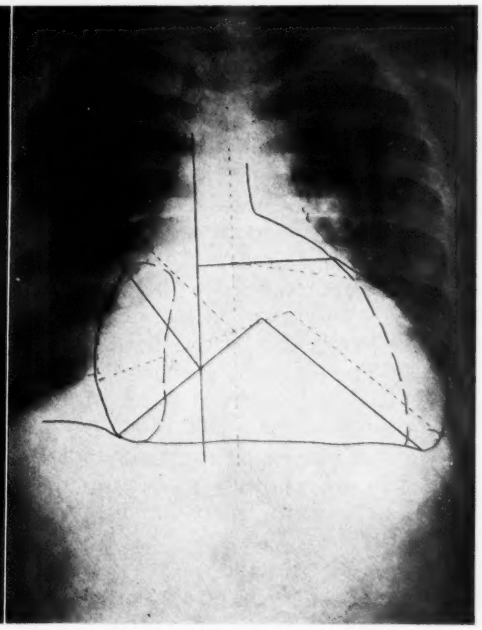

Fig. 5.

trifle too large. The "mitral stenosis" showed a predominance of our *RV* and *LA* diameters and a small *LV;* the "syphilitic aortic regurgitation" had large ventricular chords; the "hypertensive heart disease," a very markedly enlarged *LV*. And so, our measurements and expectations did not fail us. In Levene's article, we found ten illustrations in which the scale could be reconstructed. In his "mitral stenosis," our diameters indicate large auricles and a large right ventricle. In the "mitral insufficiency," both ventricles and the left auricle show enlargement with our measurements. In the "double mitral," in which he states that both ventricles and the left auricle should be larger, our measurements show both ventricles increased in size. The "aortic stenosis" and also the "aortic insufficiency" require large left ventricular and small auricular chords—our measurements give them. Levene also gives a case of sinus arhythmia and a case of extra-systole, in which he finds no alteration of cardiac contour or size, yet our measurements show a large right ventricle in both instances. On Fray's illustrations, the drawing-in of our diameters checked up with his findings. There is one instance, however, which we want to mention specifically. Figure 9, in the February, 1932, issue of the "American Journal of Roentgenology and Radium Therapy" carries the diagnosis of slight left ventricle enlargement, with the remark that the cardiothoracic ratio is normal and cardiac enlargement would have been missed if reliance had been placed on the transverse diameter of this single view. Our diameters show in this case both ventricles above normal. These results encouraged us to gather clinical material to carry out measurements in controlled cases.

All of the films used for measurements were taken in an upright position, in deep inspiration, and at a target-film distance of five or six feet. We realize that the variable distance makes a difference in the size of the heart shadow, but actual measurements showed that the divergence is only about 3 per cent, which we do not consider too great for practical purposes. Furthermore, the proportional measurement of the heart chambers remains constant at the various distances. Our scheme is based on this proportion.

Analysis of Our Data.—In Table I, we

TABLE I.—HEALTHY CASES (126): NEW METHOD MEASUREMENTS

Case	No.	LV	RV	LA	RA	Sum
	1	49	44	44	40	177
	2	52	50	44	41	187
	3	56	50	49	45	200
	5	52	56	47	65	220
N.[2]	6	58	57	43	63	221
N.	7	68	49	49	55	221
	8	55	55	57	55	222
N.	9	65	62	41	55	223
	10	71	62	40	50	223
N.	11	70	57	52	45	224
N.	12	61	60	42	61	224
N.	13	65	58	45	57	225
	14	75	66	37	47	225
N.	15	60	46	53	67	226
N.	16	74	55	50	47	226
N.	17	69	58	46	55	228
N.	18	69	59	48	53	229
	19	70	54	49	56	229
	21	72	61	46	50	229
	23	72	45	57	56	230
	24	65	55	53	57	230
N.	25	73	70	42	46	231
N.	26	69	64	44	54	231
N.	27	60	56	57	58	231
	28	66	59	47	59	231
N.	29	70	60	54	49	233
	30	71	52	48	62	233
N.	32	65	68	44	58	235
N.	34	68	65	50	53	236
	35	66	65	49	56	236[3]
	36	62	64	46	65	237
	38	69	61	50	57	237
N.	39	62	67	52	57	238
	40	61	61	52	61	238
	41	63	60	55	60	238
	42	75	60	53	50	238
	43	64	66	54	54	238
	44	78	63	50	48	239
	45	62	68	53	56	239
N.	46	69	65	53	53	240
N.	47	62	63	53	62	240
	48	74	54	54	58	240
	49	75	61	51	53	240
N.	50	72	70	44	55	241
N.	51	78	70	46	47	241
	52	65	63	50	63	241[4]
N.	54	72	69	46	55	242
	55	75	69	42	57	243
	56	72	63	56	52	243
	57	66	69	60	48	243
N.	58	74	66	49	54	243
	59	70	57	57	59	243
N.	61	74	69	43	58	244
	63	62	57	60	65	244
	66	69	67	49	60	245
N.	67	88	68	40	50	246
N.	68	71	72	43	60	246
N.	69	65	66	50	65	246
N.	70	76	65	52	53	246

Case No.	LV	RV	LA	RA	Total
N. 71	81	74	41	51	247
72	78	64	44	52	248
N. 73	60	73	56	60	249
N. 74	75	57	61	56	249
75	68	59	52	50	249
N. 76	76	70	49	55	250
77	78	64	56	52	250
78	72	70	48	60	250
79	77	68	52	53	250
80	76	68	53	53	250
N. 81	85	64	52	50	251
N. 82	80	61	57	53	251
84	80	61	55	54	251
86	77	64	56	54	251[3]
87	75	70	55	51	251
88	68	64	63	56	251
N. 89	71	65	65	51	252
91	71	64	58	59	252
N. 92	80	69	50	54	253
93	74	63	55	62	254
94	74	61	59	60	254
95	78	58	61	57	254
96	51	61	65	77	254[5]
98	78	65	56	56	255
102	65	64	62	65	256
103	85	61	64	46	256
104	82	69	49	56	256
N. 105	74	63	68	52	257
106	78	63	59	57	257
107	89	60	54	54	257[4]
N. 108	77	65	53	62	257
109	84	75	45	53	257
111	70	60	63	54	257
N. 112	78	76	48	56	258
113	78	66	56	58	258
115	73	70	57	59	259
N. 116	83	71	55	51	260
117	69	71	59	61	260
122	78	71	61	51	261
123	70	74	56	61	261
N. 124	70	76	55	61	262
N. 125	83	66	62	51	262
127	86	70	46	60	262
132	79	65	55	64	263
133	70	69	60	64	263
134	78	68	56	61	263
N. 135	87	68	57	52	264
136	71	68	57	68	264
137	79	71	58	56	264
N. 138	74	74	56	61	265
N. 139	74	73	59	59	265
N. 140	83	76	50	56	265
N. 141	74	75	62	54	265
143	75	77	64	50	266
144	72	69	69	57	267
151	83	66	67	56	272
155	86	68	60	60	274
157	80	77	59	59	275
158	69	73	68	65	275
162	85	77	49	67	278[6]
163	75	75	58	70	278[6]
166	80	73	65	62	280
N. 167	79	78	73	51	281[7] (Ex.)
169	83	71	63	64	281
N. 176	83	76	65	62	286
177	88	75	57	68	288
N. 179	80	77	71	61	289[7] (In.)

[2] Nurse.
[3] Same person, six months later.
[4] Films taken one and one-half years apart.
[5] Pathology in RA is possible.
[6] Films taken one week apart.
[7] Inspiration and expiration.

TABLE II.—HEALTHY CASES (126): VAQUEZ-BORDET MEASUREMENTS

Case No.	LV	RV	LA	RA	Total
1	52	72	43	43	210
2	52	79	43	47	221
3	52	81	49	51	233
5	58	80	43	*71*[8]	252
6	65	80	40	*75*	260
7	76	82	46	65	269
8	58	82	52	68	260
9	80	81	40	*77*	278
10	82	88	40	65	275
11	75	95	51	58	299
12	74	80	35	*88*	277
13	68	93	38	69	268
14	81	98	37	58	274
15	74	70	47	*76*	267
16	79	95	50	59	283
17	75	101	42	65	283
18	77	89	47	67	280
19	78	90	47	64	279
21	79	95	46	65	285
23	85	84	*54*	65	288
24	68	92	50	61	271
25	80	101	42	65	288
26	77	90	42	*70*	279
27	80	77	*55*	*71*	283
28	80	82	45	*75*	282
29	75	99	*53*	60	287
30	86	80	46	*76*	288
32	76	89	44	*76*	285
34	72	98	50	66	286
35	76	91	49	*72*	288
36	75	86	43	*82*	286
38	84	85	49	*72*	290
39	76	87	*52*	*76*	291
40	67	91	50	*72*	280
41	72	88	*53*	*71*	284
42	78	102	*51*	61	292
43	66	100	*52*	*66*	284
44	82	106	50	59	297
45	72	84	*51*	*68*	275
46	69	106	*51*	62	288
47	72	87	50	*78*	287
48	85	87	*53*	*70*	295
49	87	93	*51*	*66*	297
50	80	98	43	*76*	297
51	*92*	101	46	*68*	307
52	77	88	48	*77*	290
54	*89*	91	46	*80*	306
55	78	104	40	57	279
56	76	102	*55*	64	297
57	58	116	*59*	51	284
58	*86*	91	44	*73*	294
59	82	89	*56*	*69*	296
61	*87*	97	40	*80*	304
63	66	90	*55*	*75*	286
66	83	91	48	*77*	299
67	*98*	100	38	*72*	308
68	77	97	40	*80*	294
69	75	88	47	*82*	292
70	82	110	*52*	57	301
71	*90*	106	41	*71*	308
72	79	114	44	*69*	308
73	61	104	*54*	60	279
74	*86*	98	*61*	*67*	314
75	75	94	*52*	59	280
76	*86*	110	45	*70*	311
77	77	114	*55*	63	309

[8] Cases in italics are considered abnormal according to Vaquez.

Case No.	LV	RV	LA	RA	Total
78	*86*	91	48	*79*	306
79	*87*	99	*52*	*71*	309
80	82	106	*53*	*68*	309
81	*91*	109	*52*	63	315
82	*90*	100	*57*	66	333
84	*86*	105	*55*	*67*	313
86	*89*	100	*55*	*71*	315
87	75	113	*55*	65	308
88	68	100	*60*	62	290
89	74	105	*62*	*73*	314
91	83	95	*57*	*74*	309
92	83	110	49	*73*	315
93	83	98	*53*	*78*	312
94	*89*	94	*57*	*75*	315
95	74	110	*59*	58	301
96	53	85	*51*	*80*	269
98	78	112	*55*	*68*	313
102	75	93	*61*	*76*	315
103	77	122	*64*	54	317
104	*86*	112	48	70	316
105	78	118	*66*	62	324
108	83	100	*51*	*78*	312
106	*90*	102	*59*	*68*	319
107	*92*	114	*51*	64	321
109	*92*	111	45	*74*	322
111	75	97	*61*	65	298
113	*89*	120	*56*	*74*	339
112	80	115	48	*72*	315
115	78	108	*56*	*70*	312
116	84	120	*53*	*68*	325
117	77	112	*57*	*67*	313
122	77	121	*61*	*62*	321
123	77	105	*55*	*76*	313
124	76	105	*52*	*80*	313
125	*87*	114	*62*	65	328
127	*95*	102	45	*78*	320
132	*89*	101	*53*	*76*	319
133	78	102	*57*	*75*	312
134	77	116	*54*	*66*	313
135	*91*	118	*57*	64	330
136	82	95	*54*	*84*	315
137	79	117	*57*	66	319
138	80	102	*51*	*83*	316
139	75	113	*53*	*75*	316
140	*87*	116	44	*74*	321
141	80	113	*62*	*70*	325
143	70	127	*64*	58	319
144	68	122	*67*	*70*	327
151	*86*	116	*65*	67	334
155	*93*	112	*59*	*73*	337
157	81	118	*57*	*75*	321
158	74	109	*64*	*76*	323
162	*94*	105	47	*90*	336
163	*89*	100	*56*	*90*	335
166	*98*	106	*59*	*79*	342
167	66	134	*73*	62	335
169	*96*	119	*63*	*77*	355
176	86	122	*64*	*77*	349
177	*91*	122	*56*	*73*	342
179	84	125	*68*	*78*	355

The normals of Vaquez are:
LV: from 67 mm. to 85 mm.
RV: from 85 mm. to 147 mm.
LA: from 35 mm. to 50 mm.
RA: from 35 mm. to 65 mm.

arranged our measurements of 126 healthy persons. In Table II, same persons and same grouping, the Vaquez-Bordet measurements are given and all the figures that fall outside the normals of Vaquez are marked. Notice how often these measurements transcend his normals in healthy and in hardworking persons. Part of the material in these tables is furnished by 50 healthy student nurses, marked in the table with an "N." This selected group was carefully checked clinically, easily kept under observation, and was available for check-up. In this sub-group of 50, the left ventricle appears larger than normal in 14 cases, the left auricle larger in 21 cases, and the right auricle larger in 36.

Our own diameters were arranged according to the sum of the individual diameters, which we claim may be used as an index of the size of the heart. Please note that the mean average of all of our diameters, mainly that of the ventricles, increases proportionately with the size of the heart, and, also, that the sum of the diameters is in correlation with the area of the hearts as expressed in square centimeters (see Table III)—a fact which could not be said of the Vaquez figures. We offer Table IV as proof that the area in square centimeters is predictable from the sum of the diameters, the error in prediction not being more than, in average, 10 or 15 per cent, which we estimate to be a rather good result, considering the difficulty of an accurate area measurement. Whether one uses a planimeter or a celluloid sheet ruled in square centimeters, counting squares and estimating fractions, the upper and the lower heart border has to be guessed; therefore, an accurate area measurement is impossible.

The figures given in Tables I and II are analyzed in Table V and in Chart I. The table compares the millimeter range and the mean average of the individual diameters in health and in disease. Each chamber is treated separately; the first line shows the normal figures, then are shown the four groups of pathologic findings. This table, together with the graphic presentation of Chart I, clearly demonstrates that the absolute length of the diameters is dependent on the size of the heart. Therefore, it is not enough, as it is now custo-

mary, to state the length of a diameter: it is also necessary to give the size of the heart in which it is found. Our method makes that reference rather easy: simply give the sum of the individual diameters. For instance, a left ventricular chord of 86 mm. may be normal in a heart of medium size of a sum of 260, but it will have to be regarded as pathologic, or at least on the borderline of pathologic, in a small heart of a sum of 230. Chart I is not only a graphic presentation of the data of the foregoing table, but also a comparison of the Vaquez method with ours. The interrupted lines

TABLE III.—SHOWING RELATION OF FRONTAL AREA TO THE SUM OF DIAMETERS

Area (sq. cm.)	Number of cases in groups of the sum of diameters												
	220–229	230–239	240–249	250–259	260–269	270–279	280–289	290–299	300–309	310–319	320–329	330–339	460–469
65–69	3												
70–79	12	3	3										
80–89		13	19	5									
90–99		1	4	22	12		2						
100–109			2	4	12	5	2						
110–119						6	7	3					
120–129						1	1	3	3				
130–139								3	2	3			
140–149								1	1		2	1	
150–159										2			
160–169												1	
170–179													
180–189												1	
240–249													2

TABLE IV.—AREA (SQ. CM.) PREDICTED FROM THE SUM OF THE DIAMETERS

Case No.	Total	Predicted (area)	Measured (area)	Error	Case no.	Total	Predicted (area)	Measured (area)	Error
21	229	76–82	79	±3	144	267	104	103	−1
23	230	80	79	−1	146	268	108	106	−2
28	231	82	84	+2	150	271	104	115	11
30	233	84	82	−2	151	272	108	114	6
42	238	84	86	+2	152	273	100–120	127	7, 27[9]
44	239	86	90	+4	153	273	110	102	−8
48	240	82	83	1	155	274	108	114	6
56	243	84	89	5	156	274	114	116	2
57	243	84	81	−3	157	275	108	109	1
59	243	82	90	8	160	277	108	119	11
60	243	80	78	−2	168	281	104	108	8
75	249	90	89	−1	180	289	112	112	0
78	250	90	89	−1	181	289	120	127	7
85	251	90	96	4	184	291	115	126	11
87	251	94	95	1	182	290	114	119	5
91	252	90	96	6	185	293	120	128	8
93	254	86–94	91	−5	186	294	120	126	6
94	254	90	98	8	187	294	124	139	15
98	255	90	85	−5	188	294	126	143	17
99	255	95	93	−2	189	296	125	131	6
109	257	98	105	7	191	298	122	133	11
110	257	95	106	11	192	299	115–125	112	−3, 13
113	258	98	104	6	194	303	126	134	8
121	261	94–104	103	−1, 9	195	303	134	148	14
122	261	100	109	9	201	311	126	152	26
127	262	98	94	−4	203	315	135	139	4
129	262	78–84	96	18, 12	206	319	150	153	3
130	263	100	104	4	211	339	155	169	14
132	263	100	109	9	219	460	230	242	12
143	266	102	105	3					

[9] This is the greatest error: 21 per cent.

show the Vaquez measurements. This chart demonstrates at a glance that our figures show sufficient clearance between health and disease, but, on the other hand, we cannot find a guiding rule from the Vaquez curves.

We divided the pathologic cases into four groups, comprising not only the clearly pathologic but also the suspected ones, according to the outstanding enlargement of the individual chambers.

In Group I, only the LV is large—26 cases
In Group II, LV and RV are large—26 cases
In Group III, only the RV is large—28 cases
In Group IV, some auric. diam. is large—14 cases
Thus we find large LV in 52 cases, 55 per cent
large RV in 54 cases, 57 per cent
large LA in 7 cases, 7 per cent

TABLE V.—COMPARATIVE TABLE OF DIAMETERS IN HEALTH AND DISEASE: NEW METHOD MEASUREMENTS

Diameters and groups		Heart size groups									
		177–219	220–229	230–239	240–249	250–259	260–269	270–279	280–289	290–299	300–up
Left ventricle											
Normal	range	49–56	52–75	60–78	60–88	51–89	69–87	69–86	79–88		
	mean	52	63	69	74	70	78	76	83		
I	range	62	79–80	79–83		86–90	84–105	88–110	96–100	92–95	96–107
	mean		79	81		88	94	99	98	94	101
II	range					100	85	89	92–94	91–108	92–134
	mean								93	99	113
III	range				72	53–66	75–85	65–82	74–85	83–88	64–88
	mean					59	80	73	79	85	76
IV	range				60–71	59–85	49–80		77	75–87	86
	mean				65	72	64			81	
Right ventricle											
Normal	range	44–50	46–66	45–70	54–74	58–76	65–77	66–77	71–78		
	mean	47	56	57	64	67	71	71	74		
I	range	57	62–68	56–68		62–69	61–75	62–77	67–75	68–77	74–75
	mean		65	62		65	68	69	71	72	74
II	range					81	73	84	82	81–89	81–105
	mean									85	93
III	range				72	72–74	77–84	78–83	74–84	83–89	82–143
	mean					73	80	80	79	86	112
IV	range				63–72	64–73	64–72		67	67–77	77
	mean				67	68	68			72	
Left auricle											
Normal	range	44–49	37–57	42–57	40–61	45–68	46–69	49–68	56–73		
	mean	46	47	49	50	56	57	58	64		
I	range	53	40–46	37–57		52–61	40–68	49–60	60–64	61–68	68–80
	mean		43	47		56	54	54	62	64	74
II	range					34	50	51	42–53	47–71	45–87
	mean								47	59	66
III	range				42	50–73	44–55	53–70	53–75	45–63	76–142
	mean					61	49	61	64	54	109
IV	range				55–62	52–70	52–74		75	67–79	75
	mean				58	61	63			73	
Right auricle											
Normal	range	40–46	45–67	46–65	47–65	46–65	50–68	56–70	51–68		
	mean	43	56	55	56	55	59	63	59		
I	range	41	41–42	38–53		44–44	42–53	42–60	53–58	60–69	54–65
	mean		41	45		44	47	51	55	64	59
II	range					40	52	53	55–67	53–60	54–71
	mean								61	56	62
III	range				55	60–65	51–60	54–75	52–75	61–76	68–103
	mean					62	55	64	63	68	85
IV	range				46–60	41–61	57–75		70	68–79	75
	mean				53	51	66			73	

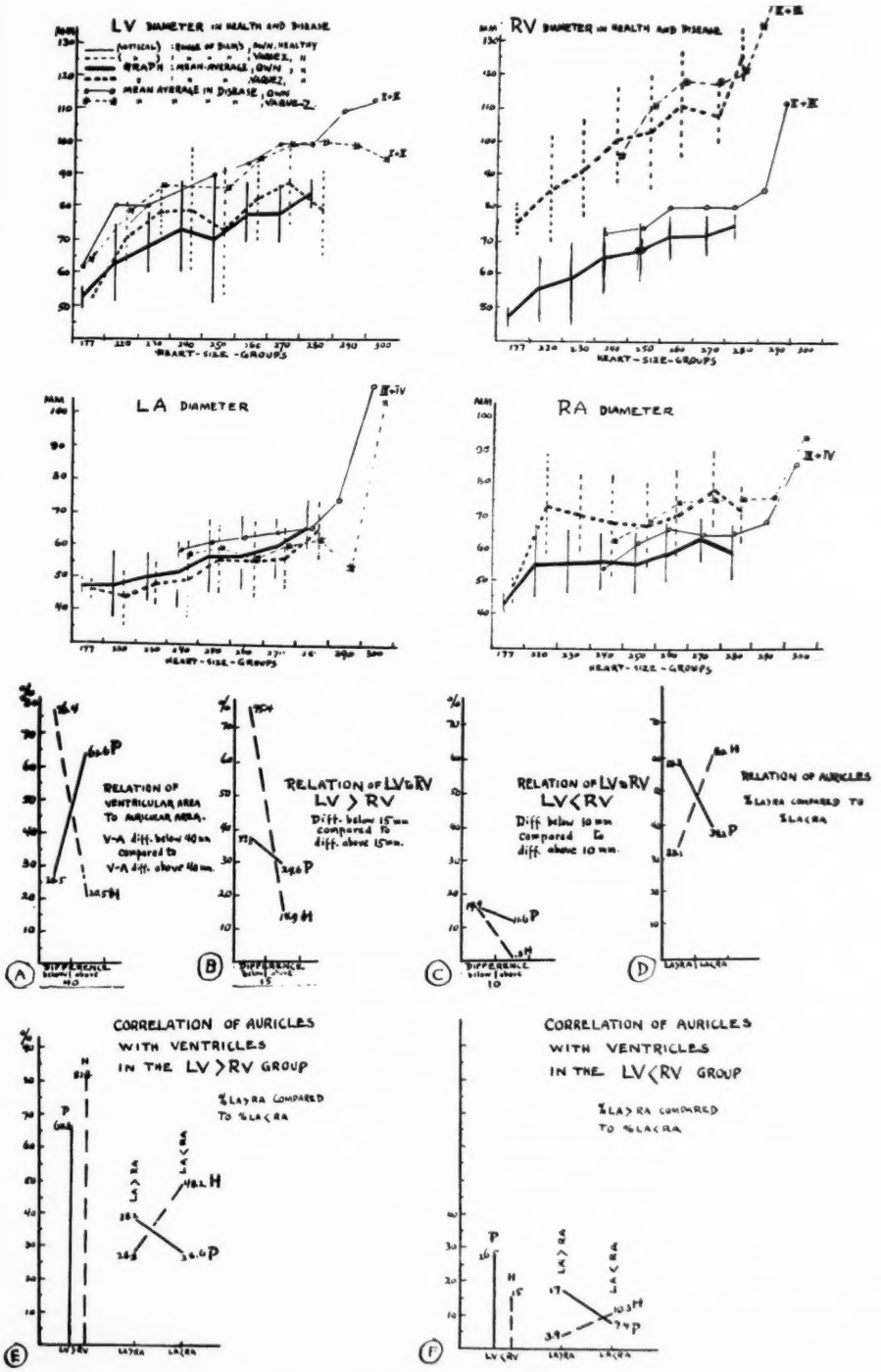

CHART I (*above*) and Chart II (*below*).

But since the left auricle indicates enlargement of the outflow tract of the right ventricle, we are justified in adding these to the right ventricle group, getting thereby a total of 64 per cent for right ventricle pathology. Of paramount importance is the question of whether or not there is a constant relationship between the individual diameters, and whether or not pathologic conditions disturb that relationship. Let us first examine the relation of the ventricular area to the auricular area. We find that in health as well as in disease the ventricles are larger than the auricles: this was to be expected. However, we get another picture if we inquire into the size-differences of the ventricles and auricles. Taking size-differences below and above 40 as our base for comparison, we find (see *A* in Chart II):

	Normal	Pathol.
Both *V* larger than both *A* by not more than 39	76.4 per cent	26.5 per cent
Both *V* larger than both *A* by more than 40	20.5 per cent	63.6 per cent

This means that small size-differences predominate in health but large size-differences are found only in disease.

Relation of the left ventricle to the right ventricle is expressed in the following figures:

	Normal	Pathol.
LV larger than RV	82.2 per cent	66.8 per cent
LV equals RV	2.4 per cent	6.4 per cent
LV smaller than RV	15.0 per cent	26.5 per cent

Normally, the left ventricle predominates over the right ventricle, while in pathology, there are almost twice as many cases having the right ventricle larger than the left ventricle. A more detailed analysis as to how much larger the diameters may be without disturbing the normal relations gives the following interesting data:

	Normal	Pathol.
LV larger than RV by less than 15 mm.	75.4 per cent	37.2 per cent
LV larger than RV by more than 16 mm.	14.9 per cent	29.6 per cent
LV smaller than RV by less than 10 mm.	14.9 per cent	14.9 per cent
LV smaller than RV by more than 11 mm.	0.8 per cent	11.6 per cent

It is evident that health and disease show opposite trends: compare also *B* and *C* on Chart II.

Coming now to the auricular diameters, we see in *D* of Chart II that in health the left auricle is smaller than the right auricle, but, in disease, the opposite holds true.

As to the correlation of the auricles with the ventricles, again comparing the number (percentage) of cases, having the left auricle larger than the right auricle, with the number (percentage) having the left auricle smaller than the right auricle first in that ventricular group in which the left ventricle is the larger diameter, and then in the other group in which the left ventricle is the smaller diameter, we may demonstrate in *E* and *F* on Chart II the clearly opposite tendencies in health and disease expressed in the crossing of the respective lines. Moreover, we may note that pathologic conditions tend to enlarge the left auricle diameter even if the left ventricle predominates over the right ventricle; this tendency is more marked if the right ventricle is larger than the left one. We may say, therefore, that pathology in the right ventricle (inflow tract) goes together with pathology in the left auricle (outflow tract).

We return now to Table V and Chart I which compare the range and the mean average of each diameter in normal and pathologic conditions. We must recall that Groups I and II show the left ventricle enlargement; Groups II and III show right ventricle enlargement. Keeping this in mind, we find the differences between the normal and pathologic satisfactory. The left ventricle mean is large in Groups I and II, but it is smaller than the normal in Group III, which means that the right ventricle pathology diminishes the length of the left ventricle diameter. This agrees excellently with our pathologic experiences which show that a hypertrophied right ventricle rotates the heart and pushes the left ventricle backward, crowding it out of the frontal silhouette. This fact is also borne out by the left auricle figures which are smaller than normal in Groups I and

II: the enlarged left ventricle diminishes the size of the left auricle on the frontal film (left auricle: outflow tract of the right ventricle).

We also found a constant relationship of the left ventricle and the right auricle diameters. This relationship is chiefly affected by the height of the diaphragm, at least in drop-hearts. We see from Table VII that in drop-hearts we may expect a large right auricle together with a small left ventricle and right ventricle, but when the diaphragm is high this ratio is reversed and we find a relatively large left ventricle and right ventricle with a small right auricle.

Testing Our Method.—In order to test the reliability of our measurements we compared the diameters in hearts x-rayed on two different occasions and give the figures

TABLE VI.—PATHOLOGICAL CASES (94): NEW METHOD MEASUREMENTS

Case No.	LV	RV	LA	RA	Total
Group I (LV pathol.)					
4	*62*	57	53	41	*213*
20	*80*	68	40	41	229
22	*79*	62	46	42	*229*
31	83	56	57	38	234
33	79	68	46	42	235
37	79	68	37	53	237
85	86	69	52	44	251
101	90	65	57	44	256
110	90	62	61	44	*257*
118	92	70	51	47	260
121	90	61	68	42	261
129	84	69	56	53	262
126	94	75	46	47	262
130	105	72	40	46	*263*
148	87	74	49	60	270
150	88	74	56	53	271
152	91	73	54	55	273
154	96	77	50	51	274
156	110	62	60	42	*274*
173	100	67	64	53	284
181	96	75	60	58	*289*
184	95	73	61	62	291
189	92	68	67	69	296
190	92	77	68	60	*297*
194	96	74	68	65	303
204	107	75	*80*	54	316
Group III (RV pathol.)					
53	72	72	42	55	*241*
100	66	74	50	65	255
114	53	72	73	60	*258*
131	82	77	44	60	263
146	85	77	49	55	268
142	75	78	55	58	266
147	84	84	49	51	*268*
149	82	78	57	54	271
153	65	83	70	55	273
159	69	80	70	57	276
161	79	81	53	65	278
164	69	82	53	75	*279*
165	78	78	57	67	280
168	75	81	68	57	281
170	79	80	71	52	282
171	85	84	53	60	282
175	81	75	57	72	285
178	74	74	75	65	*288*
183	83	83	63	61	290
191	88	89	45	76	298
198	75	82	*81*	68	306
205	78	88	76	77	319
206	72	84	*84*	79	319

Case No.	LV	RV	LA	RA	Total
Group II (LV and RV pathol.)					
97	100	81	34	40	*255*
119	85	73	50	52	*260*
160	89	84	51	53	*277*
172	92	82	53	55	282
174	94	82	42	67	285
185	91	82	67	53	293
186	99	89	48	58	294
187	98	82	54	60	294
188	108	84	47	55	294
193	94	81	71	53	299
195	101	91	49	63	303
196	100	98	53	54	305
197	92	85	72	56	305
199	115	92	45	55	*307*
201	107	91	53	60	311
202	102	87	62	60	311
203	100	81	78	56	*315*
207	99	94	68	62	323
208	111	83	72	57	*323*
209	94	82	*81*	70	327
210	105	95	70	64	334
211	113	81	*81*	64	339
212	106	104	74	60	344
214	110	98	78	71	357
215	115	100	*87*	65	367
216	134	105	73	68	380
213	64	98	*92*	92	346
217	85	106	*103*	87	381
218	86	113	*122*	76	397
219	79	136	*142*	103	460
220	81	143	*135*	102	461
Group IV (suspected)					
60	60	63	60	60	243
62	63	67	*62*	52	244
64	71	71	57	46	245
65	67	72	55	51	245
83	85	73	52	41	251
90	59	67	*68*	58	252
99	60	64	*70*	61	*255*
120	74	72	58	57	261
127	49	64	*74*	*75*	262
145	80	66	52	*69*	*267*
180	77	67	*75*	*70*	289
182	87	67	67	*69*	290
192	75	77	*79*	68	299
200	86	77	*75*	*71*	309

TABLE VII.—COMPARISON OF DIAMETERS IN DROP-HEARTS (LOW DIAPHRAGM) AND PUSHED-UP HEARTS (HIGH DIAPHRAGM): NEW METHOD MEASUREMENTS

Diameter	Range and mean of diameters in size-groups in low and high diaphragms					
	220–229		230–239		240–249	
	Low diaphr. (drop-hrt.)	High diaphr.	Low diaphr. (drop-hrt.)	High diaphr.	Low diaphr. (drop-hrt.)	High diaphr.
LV	52–70 61	69–74 71.5	60–72 66	68–73 70.5	62–74 68	60–78 69
RV	46–60 51	55–59 57	45–68 56	60–70 65	54–69 61	57–73 65
LA	42–53 47.5	48–50 49	46–57 51.5	42–54 48	46–60 53	42–61 51.5
RA	55–67 61	47–53 50	56–65 60.5	46–53 49	55–65 60	47–65 56

TABLE VIII.—MEASUREMENTS IN HEARTS RADIATED ON TWO DIFFERENT OCCASIONS: NEW METHOD MEASUREMENTS

No.	LV	RV	LA	RA	Total	Sq. cm.	Transv.	
35	66	65	49	56	236	81	103 mm.	Second exposure 6 months later; heart larger;
86	77	64	56	54	251	93	114	increase may be expected.
52	65	63	50	63	241	84	103	Second exposure almost two years later; pa-
107	89	60	54	54	257	100	114	tient had pneumothorax, high right diaphr.; larger heart.
137a	79	61	56	61	257	90	116	Second exposure two and one-half months
137	79	71	58	56	264	102	120	later: right diaphr. higher; right auriculo-diaphr., point uncertain.
162	85	77	49	67	278	117	130	Second exposure 2 weeks later: there *is* a slight
163	75	75	58	70	278	120	138	difference in the absolute size and in position of heart.
167	79	78	73	51	281	95	145 (insp.)	Shows effect of height of diaphr. on position
179	80	77	71	61	289	110	136 (expir.)	and diameters.
199	115	92	45	55	307	148	157	Second exposure 2 weeks later. Mitral di-
202	102	87	62	60	311	148	163	sease, decompensated.
165	78	78	57	67	280	130	108	Second exposure 4 months later: incipient de-
153	65	83	70	55	273	102	142	compensation.
213	64	98	92	92	346	155	154	Second exposure 5 months later: decompen-
217	85	106	103	87	381	185	182	sated mitral.

The greatest difference between the measurements of the same diameter amounts to 16 per cent (in the LV of Nos. 35 and 86; and in the RV of Nos. 137 and 137a) but both measurements remain within the normal limit.

In the lower three pathologic cases, the change in the length of the diameters is explained by the change in the size of the heart, but the second radiation, too, shows the respective pathology.

in Table VIII. We make the following deductions: the greatest differences do not amount to more than 16 per cent and even then they remain within the normal limit, or show the same pathology, respectively.

A comparison of our radiologic findings with the clinical diagnosis gives the following results. In Groups I and II, left ventricle enlargement, the clinician diagnosed aortic lesion in 57.5 per cent of the diagnosed heart cases, and mitral disease in 20 per cent of the cases; while in Group III, right ventricle enlargement, aortic lesion was claimed in 41 per cent only and mitral in 30 per cent. We also compared our method with that of Hodges and Eyster. In Table IX the predicted and measured area and transverse diameter of 50 healthy student nurses are tabulated; however, the variation is too wide, and in some cases it would even indicate pathology, although clinically none of the girls showed any evidence of cardiac disease. In a few cases we were able to compare our measurements with figures according to the Fray method. The results, as can be seen from Table X,

TABLE IX.—AREA (SQ. CM.) AND TRANSVERSE DIAMETER (MM.) ACCORDING TO THE HODGES AND EYSTER FORMULA COMPARED WITH ACTUAL MEASUREMENTS

	Sq. cm. area		Transverse		
No.	Predict.	Found	Predict.	Found	Diff. ± mm.
6	89.4	68	101?	92	− 9
7	89.3	68	102?	90	−12
9	91	76	98?	100	+ 2
11	90.4	72	104?	107	+ 3
12	92.7	75	100?	97	− 3
13	92.5	70	114	96	−18
15	88.6	72	104?	89	−15
16	94.3	74	118	103	−15
17	85.8	78	110	102	− 8
18	87.9	79	110	101	− 9
25	89.7	81	110	106	− 4
26	98.4	79	115	94	−21
27	90.9	84	105	101	− 4
29	89.8	80	112	110	− 2
32	98.5	77	110	103	− 7
34	88	82	108	104	− 4
39	100.2	84	110	102	− 8
46	97.6	80	111	106	− 5
47	85.4	81	109	101	− 8
50	—	85	—	117	..
51	93.4	87	109	109	0
54	89.7	90	104	107	+ 3
58	88.4	86	113	103	−10
61	92.5	89	114	113	− 1
67	92.2	100	109	120	+11
68	90.8	84	110	105	− 5
69	90.2	83	106	109	+ 3
70	97.8	87	124	116	− 8
71	92.2	100	125	139	+14
73	96	88	114	115	+ 1
74	105.5	88	116	104	−12
76	96.2	92	112	115	+ 3
81	97	94	128	126	− 2
82	99	96	119	111	− 8
89	91.6	91	104	114	+10
92	99.6	92	116	120	+ 4
105	94.8	90	113	112	− 1
108	95.2	90	109	109	0
112	111.6	98	131	121	−10
116	91.5	93	112	126	+14
124	103.6	96	118	123	+ 5
125	86.4	98	116	109	− 7
135	102.6	100	127	121	− 6
138	100.5	95	115	122	+ 7
139	99.7	92	111	125	+14
140	96.2	100	112	127	+15
141	94.1	103	111	125	+14
167	97.4	95	108	136	+28
176	108.2	110	122	126	+ 4
179	97.4	110	108	145	+37

are similar. But we claim our method to be superior since it can be used in nearly any good *P-A* film with no specific radiographic technic.

Comment.—When we originally started our investigations we had the Vaquez method only in mind. We saw the unexplainable discrepancies of the left and right auricle diameters, the insufficient variation of the left ventricle diameter, and thought we might improve on the method. Later on, other methods were studied.

The prediction formulas of Hodges and Eyster, especially that for the frontal area, seem to be workable, but they contain many sources of error because the correlation of the heart with other body characteristics is inconstant. "The heart type is not in harmony with the subject's general anthropmetric type. It is impossible to deduce cardiovascular behavior directly from the external morphologic type of constitution." (Pende: Constitutional Inadequacies. Lea & Febiger, 1928, p. 61.) The cardiothoracic ratio has been proven unreliable.

Rigler's method of showing the displacement of the esophagus by the enlarged left auricle is valuable, as is the method of Nichols and Ostrum, who utilize for the same purpose the right oblique position. Neither method is standardized although it may be and should be resorted to when information on the left auricle itself is needed.

Fray's method gives a fairly good idea of the relative sizes of the ventricles, but due to the difficulties in locating their "septum line," the ventricle measurements are a bit changeable: neither will this position show the relation of the left auricle to the esophagus. A common objection against these methods is that they require a second posture (lateral or oblique) as a routine measure, and this must be an exact posture.

Our own method, we think, shows possibilities. It demonstrates unquestionably the enlargement of the ventricles, and it is the first method to differentiate between inflow and outflow tract pathology of the right ventricle on the frontal plane without making additional films. Furthermore, we offer means whereby the cumbersome and unreliable area measurement can be done away with and supplemented by a figure at which it is easy to arrive. To our knowledge, we are the first to take the atrio-ventricular ostia into account when measuring the individual chambers on the

frontal plane, claiming that the ostia are the logical starting points, since they remain centrally located regardless of how large the chambers may become or in what direction they grow. We also claim that our diameters are laid in the direction of the greatest pathologic enlargement of the chambers. To our knowledge, we are the first who take into account the proportions of the chambers from one to the other, and to the size of the heart. We realize that there is room for further improvement, but we think that the method itself is workable and worth studying.

CONCLUSIONS

1. A study of 126 healthy and 94 pathologic, a total of 220, hearts was made and a new method of mensuration in the frontal plane is presented.

2. The method demonstrates the enlargement of either or both ventricles; it is the first method to differentiate between inflow and outflow tract pathology on the

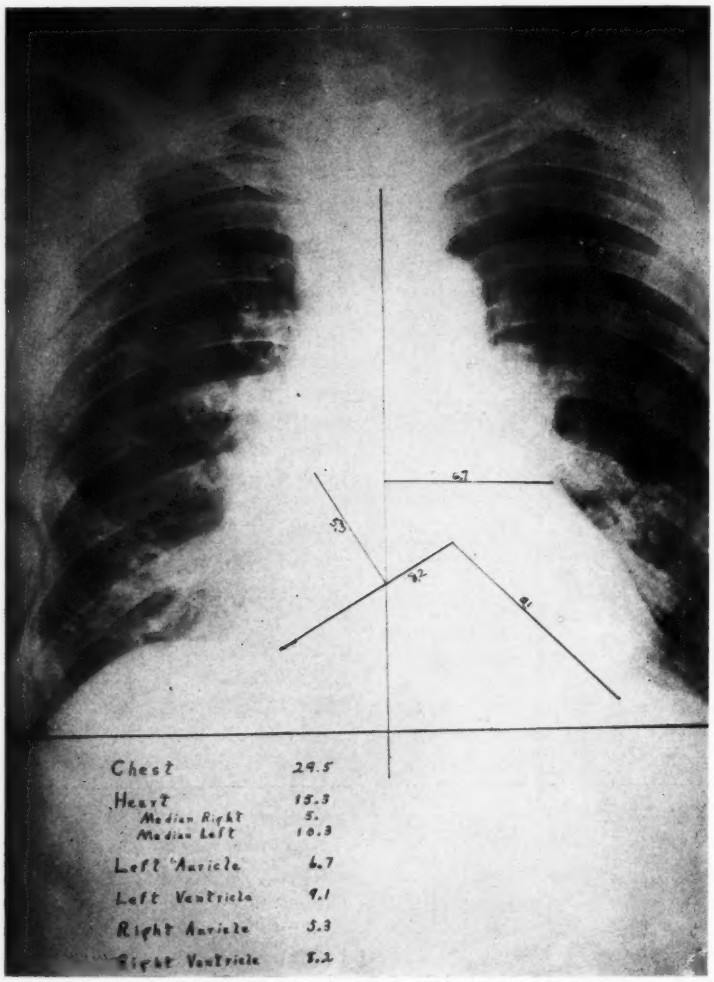

FIG. 6.

TABLE X.—COMPARISON OF DIFFERENT METHODS OF MEASUREMENT

No.	Pathology found in diameters of			Area		Transverse		Cardio-thorac.
	Own	Vaquez	Fray	Predic.	Found	Predic.	Found	
53	RV	RA	RV	92.2	88	106	122	Normal
80	Normal	LA; RA	Normal	101	82	—	122	Normal
96	?RA	LA; RA	RV	—	—	—	—	Normal
158	Normal	LA; RA	RV	—	—	—	—	Normal
175	RV	LV; LA; RA	Normal	—	—	—	120	Normal
193	LV; RV	LV; LA; RA	LV	106.4	136	130	150	Path.
199	LV; RV	LV; RV; RA	LV; RV	103	148	125	157	Path.
217	RV; LA; RA	RV; LA; RA	LV; RV	104	185	114	82	Path.

frontal plane without making additional films.

3. The method shows a reliable correlation of the various diameters to each other and to the size of the heart.

4. The method makes the cumbersome and unreliable frontal area measurement superfluous, and supplements it with figures at which it is easy to arrive.

5. The range and the mean average of our diameters show a characteristic change in, and according to, the pathology of the ventricles.

6. Normally the left ventricle is the longest diameter, but if the right ventricle is longer, be suspicious of pathology.

7. Normally the right auricle is longer than the left auricle; pathologic conditions tend to enlarge the left auricle; pathology in the right ventricle (inflow tract) goes together with pathology in the left auricle (outflow tract).

8. Comparison shows the value of our method against other methods.

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MORE ON X-RAY PROTECTION STANDARDS[1]

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THE earliest injuries resulting from over-exposure to x-rays were mostly of a superficial nature and usually they were described as roentgen dermatitis. Most of these injuries were caused when x-ray tubes were tested with hand fluoroscopes and with the free bare hand as a test object, or they resulted from prolonged fluoroscopic examinations and accidental over-exposures when x-rays were applied for therapeutic purposes. Injuries of this kind are usually not accompanied by very extensive changes of the internal organs and of the blood, and in all probability, the immediate causes of radiation injuries to the surface of the skin from over-exposure, especially to non-filtered rays, have in recent years been practically avoided (1). This protection against soft rays is brought about mostly by educational accomplishments which now induce operators to protect themselves by avoiding over-exposures to the soft rays that are absorbed in the superficial layers of the skin and which cause roentgen dermatitis.

However, in more recent times we have seen forceful evidence of a growing danger of injuries resulting from over-exposures to x-rays in particular such as are due to the accumulative character of doses and which are found to lead to the development of anemia, blood changes, uncontrolled cell growth, etc. These injuries to internal organs are mostly caused by well-filtered rays of higher penetrative power.

We can, therefore, recognize two periods and two types of roentgen injuries: the first, due to over-exposure to soft or non-filtered rays, and the second, caused by highly penetrating and unusually highly filtered rays. Of these, the first have now practically disappeared and are, therefore, no longer an important subject for discussion, but the status of the injuries caused by the more highly penetrating radiations on the internal organs is quite different in many respects. For instance, because of the great length of time required for the accumulation of injurious doses, and the long latent period following the application of hard rays before the resulting changes are positively recognized, it happens that in many cases internal roentgen injuries are either overlooked or are recognized only when they have already become fatal. For such reasons, therefore, it seems that the number of internal roentgen injuries is in all probability larger than is usually assumed and admitted.

Facing these facts and finding that some apparently erroneous conclusions regarding protective standards have appeared in the literature (2), it would seem justified to review the subject, especially on the internal injuries in their relation to the present-day accepted safety rules.

The Problem.—Undoubtedly the most important experimental work leading to the establishment of the present safety rules, which are accepted and adopted by the Committees in various countries, is that of Glocker and his associates (3). Behnken (4), and van der Tuuk and Boldingh (5). These authors have measured the radiation doses that are transmitted through various thicknesses of lead and other protective substances, and have recommended lead thicknesses for protective screens for use against radiations produced by various voltages. As a unit or tolerance dose, they accepted the measurements made by the present author in long established laboratories, which results have been corroborated since then in other ways (6). The radiation tolerance dose measured, and as originally proposed, is $^1/_{100}$ part of a skin tolerance

[1] Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

dose per month (6). According to our present knowledge, this dose is absolutely safe for continuous toleration by normal healthy individuals, provided that certain specified hygienic and recreational rules are followed. From the physical point of view, therefore, it would seem that these measurements and the results embodied in the safety protective rules are sound and that they can be unhesitatingly recommended. But there are now further facts regarding the rays of higher penetrative power which have become known through therapeutic application of x-rays, and these facts give rise to new aspects.

In the first place, we now have the definite conclusion from observations and experience in radiation therapy that x-rays of various wave lengths act differently upon human tissues, and that different doses (measured with an ionization instrument in r) are required for a given effect upon the skin, using rays of longer or shorter wave length. For instance, with rays produced with 200 K.V. pulsating voltage, ordinarily 750 r are required for an erythema dose (7), while for non-filtered rays produced with from 70 to 80 K.V. pulsating voltage, only 340 r are sufficient to produce a similar effect upon the skin (8).

Then, in the second place, we have to keep in mind that with ionization measurements, we are really determining the effect of the rays upon a small volume, *i.e.*, that equal to the volume of the ionization chamber, and that these measurements give or imply no information regarding the total dose or radiation quantity delivered to the rest of the body tissues. Let us consider an example. If the skin is irradiated with long wave length rays, then the dose measured with an ionization chamber is approximately equal to that which is absorbed in the skin; therefore, the measured dose of 340 r is practically all absorbed in the skin, causing the erythema effect. If, however, the surface of the body is irradiated with highly penetrating filtered rays, then the ionization chamber measurement of 750 r again indicates approximately the effects of the radiation upon the skin, but in addition to that, there are large doses delivered to the deeper parts of the body. Evidently different biological effects must be expected in the two cases; in the first, when the radiation effects are superficial and on the skin only, there can be expected no very great effects upon the blood system or upon the internal, more deeply located parts. However, when, in addition to the effect so produced upon the surface layers, there is also extensive irradiation of the blood-containing organs and other radiation-sensitive body parts, such as takes place when short wave length filtered rays are used, then the picture as it applies to end-results must be a different one. Confirmation of this view is found extensively in the literature, and the cases of early radiation injuries, in the sense in which they differ from the more recent kinds of internal roentgen injuries, are further direct proof.

It follows therefrom that the x-ray doses transmitted through protective screens, as measured with ionization chambers and expressed in r, are in themselves not a sufficient or a complete indication of the safety from, or magnitude of, danger with respect to the possibility of radiation injury to the blood system or to internally located radiation-sensitive body parts. It appears, therefore, that the safety rules now accepted and followed may have to be changed so as to provide sufficient and adequate protection to prevent the developing of serious internal injuries, such as are now possible and probable due to over-radiation from insufficient protection.

Experimental Conditions.—As outlined in the foregoing paragraphs, we have at this moment reliable proof that doses measured by ionization of long wave length rays possess a greater degree of actinity upon the skin or surface layers of the body than do equal doses of short wave length rays, such as are applied for deep therapy. The ratio, as known to-day, in terms of ionization measure-

ment, is as 340 r, for the low voltage unfiltered rays, is to 750 r, for high voltage filtered rays. This fact alone, or rather the great difference between the two doses producing supposedly equal surface effects, is a strong indication that the various wave length bands ought to be considered separately in the study of protection rules. But then, a similar proposition arises again, when we consider more in detail the experimental conditions under which the safety tolerance dose was originally measured, as compared with the conditions under which the measurements for determining the appropriate lead thicknesses for adequate protection were made.

The safety tolerance dose was measured by the author in 1926 with an instrument of a comparatively large volume and with chamber walls which are highly transparent to long wave length x-rays. It should also be understood that in all these measurements there were not only direct or short wave length rays present in the stray radiation, but also a considerable quantity of secondary radiation intensities (an average of approximately 50 per cent), coming either from the patient or from other irradiated objects. It is, therefore, quite definite that the original measurements include not only direct and short wave length rays from the tube, but also a considerable percentage of indirect secondary or longer wave length rays. The intensities originally measured, therefore, represent two components, each of which has a different actinity upon the surface tissues, and of which one only, the short wave length component, is penetrating enough to be able to reach the internal body parts.

However, the absorption measurements of Kaye, Berthold, Glocker, van der Tuuk and others[3] were made in the customary manner, back of lead screens and with small volume ionization chambers. The intensities so measured are, therefore, only those of well-filtered, highly penetrating rays coming directly from the tube, and no secondary rays or rays of a different wave length are included. Rays of this

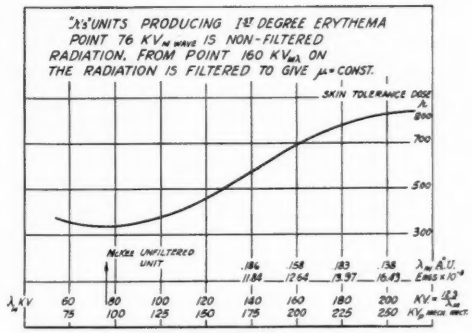

Fig. 1. Number of r required at various voltages to produce a first degree erythema dose.

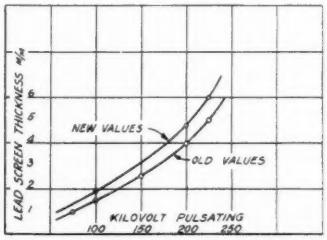

Fig. 2. (*Lower curve*), Lead thicknesses specified in U. S. Bureau of Standards Handbook No. 15; (*upper curve*) lead thicknesses required for adequate protection at various voltages.

quality are known to be relatively less actinic upon the surface layers and to require around 750 r to produce a slight erythema. But, against that, they are highly penetrating and reach the internal body parts and, in particular, the blood and the blood-forming organs.

If now, we accept the safety tolerance dose proposed by the author (or any other definite tolerance dose), we should know the relative intensities of the various wave length components present in the stray radiation against which we are to provide protection. This, as we have seen, is necessary for two reasons: First, should it happen that the entire dose of stray radiation consists of long wave length rays, then only $^1/_{100}$th part of 340 r, or 3.4 r per month (or 3 μr/sec.), is permissible; while for the short wave length stray rays, $^1/_{100}$th part of 750 r, or 7.5 r per month (or 7 μr/sec.), makes a tolerance

dose. Secondly, if, for instance, the stray radiation should consist entirely of well-filtered, highly penetrating rays and operators are exposed to the full permissible tolerance dose of $^1/_{100}$th of an erythema

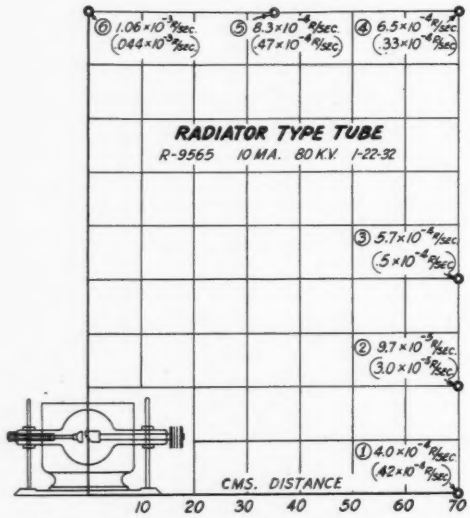

Fig. 3. Straight radiation intensities measured near the Universal type hot cathode tube.

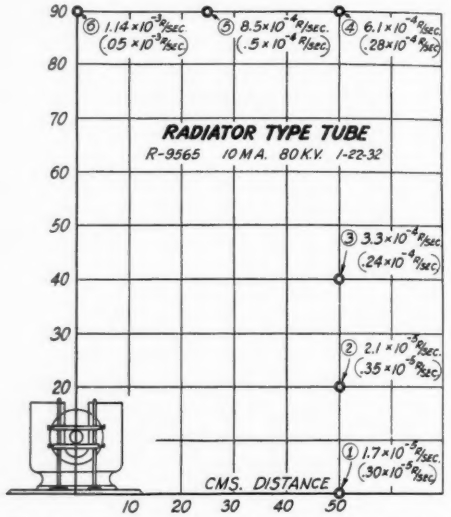

Fig. 4 Stray radiation intensities of hot cathode type tube measured at 90° of Figure 3.

dose, or to 7.5 r per month, then their internal organs would receive a considerably larger dose than that which corresponds to the proposed tolerance dose. This is so because the proposed tolerance dose contained only a fraction of short wave length rays, whereas the administered dose would consist of a full dose of penetrating rays.[2]

In both cases, therefore, unless we are quite certain that the stray radiation consists of the same mixture of ray components for which the tolerance dose was originally measured, it would seem certain that the doses actually reaching the operators are considerably larger doses than those upon which the present accepted safety rules are based. In case the stray radiation consists entirely of secondary rays, the biological effectiveness of the radiation is of the order of 750/340, or 2.2 times as large as the known tolerance dose. In case the stray radiation consists entirely of direct, well-filtered rays coming directly from the tube through the screen, then the dose received by the internal organs would be about twice what it would be according to the accepted safety tolerance dose.

In all cases, therefore, we are forced to conclude that the now accepted lead thicknesses are inadequate unless the assumed tolerance dose value is changed. So long, however, as there is no indication that this tolerance dose is underestimated, it is absolutely necessary, in order to be consistent, that these conditions be considered when recommendations for thicknesses of protective lead screens are made.

Experimental Work.—Some further deductions relative to the correctness of these conclusions can be made from the following experimental results.

(1) The stray radiation was measured with a large volume ionization chamber in several therapy clinics.[3] After the first

[2] This dose has also been expressed for normal working conditions either as one full skin dose in 20,000 hours, or as a continuous irradiation dose calculated for working hours, of an intensity of 7μr/sec. (1μr = one micro-roentgen = 10^{-6}r).

[3] For a description of the ionization chamber, see RADIOLOGY, April, 1926.

TABLE I

K.V.	Absorption coefficient μ in Pb	Normal lead protective screen (mm.)	Calculated for one-half intensity transmission (mm.)	Percentage of increase
100	1 mm. = = 65 1.5 = = 52 2.0 = = 45	1.5	1.9	25
200	1 mm. = = 48 2 = = 36 3 = = 30 4 = = 28 5 = = 25	4.0	4.75	19
220	1 mm. = = 38 2 = = 29 3 = = 25 4 = = 21 5 = = 18 6 = = 16	5.0	6.0	20

TABLE II

Points on diagrams	Stray radiation from an internally shielded x-ray tube			Stray radiation from a non-protected tube in a lead glass bowl. Plane parallel to tube			Stray radiation from a non-protected tube in a lead glass bowl. Plane perpendicular to tube		
	Full intensity μr/sec.	Filtered through 0.25 Cu μr/sec.	Ratio at full and transmitted stray radiation through 0.25 mm. Cu	Full intensity μr/sec.	Filtered through 0.25 Cu μr/sec.	Ratio at full and transmitted stray radiation through 0.25 mm. Cu	Full intensity μr/sec.	Filtered through 0.25 Cu μr/sec.	Ratio at full and transmitted stray radiation through 0.25 mm. Cu
1	3.23	1.26	2.55	1.7	0.30	5.7	40.0	4.2	9.5
2	3.22	1.25	2.56	2.1	0.35	6.0	9.7	3.0	3.2
3	3.55	1.1	3.10	33.0	2.4	14.0	57.0	5.0	11.3
4	7.18	1.7	4.20	61.0	2.8	21.4	65.0	3.3	19.2
5	11.7	4.6	3.46	85.0	5.0	17.0	83.0	4.7	17.7
6	1.9	0.72	2.65	114.0	5.0	22.0	106.0	4.4	24.3

reading had been taken, the chamber was covered with 0.25 mm. of copper as a filter for the stray radiation. On the average, when secondary radiation was present, the difference indicates an absorption of long wave length components, averaging slightly less than 50 per cent. This test, therefore, definitely proves that in many therapy clinics the stray radiation consists of a mixture of long and short wave length components.

(2) The intensity of well-filtered short wave length radiation transmitted through various lead thicknesses was measured with the same instrument, and 0.25 mm. of copper was placed into the beam in addition to the lead. There was only a very slight decrease of radiation intensity caused by the 0.25 mm. of copper, *i.e.*, corresponding to the theoretically required amount. This shows that no secondary rays are present in the directly transmitted stray radiation.

(3) The intensity of secondary radiation from an irradiated block of pine wood of form and size similar to that of a

patient was then measured. When a 0.25 mm. copper filter was placed into the path of the rays, before they reached the ionization chamber, their intensity was decreased to about 40 per cent of the original intensity. A filter of 0.5 mm. copper decreased this intensity still further—to a total value of about 18 per cent of the original intensity. These measurements show that the secondary radiation is a long wave length radiation, and generally quite completely absorbed in the outer layers of the body.

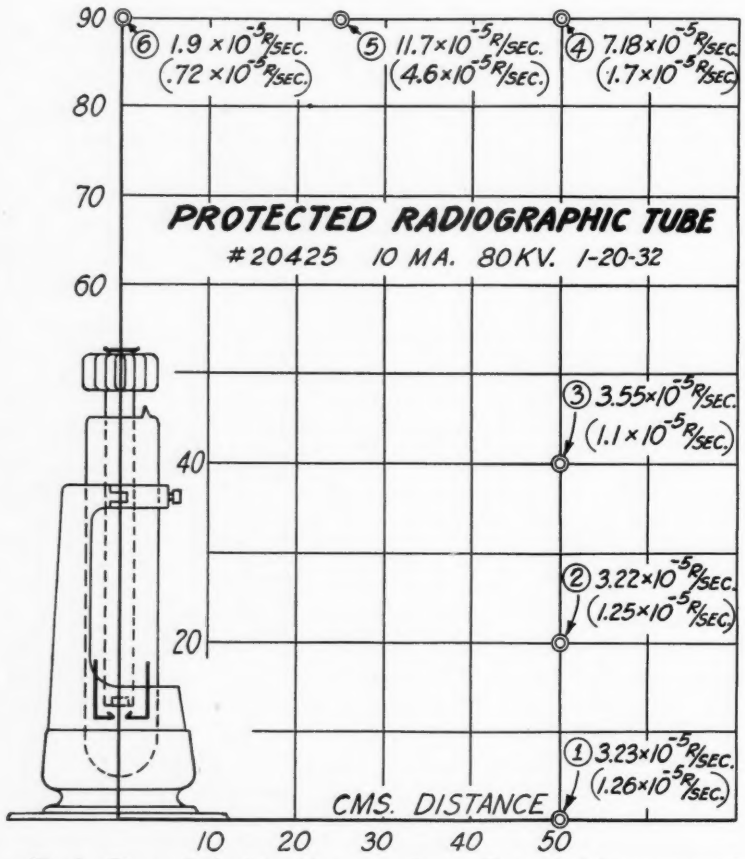

Fig. 5. Stray radiation intensities measured around hot cathode heavy protected x-ray tube.

This review of given actual conditions, and the results of these simple tests, force upon us the rather definite conclusion that ionization measurements alone are not a conclusive indication of the adequacy of protection, and that in order to maintain that accepted standard of protection, the absorption values of protection screens must be increased to transmit only about 50 per cent of the radiation intensity for which they are now accepted.

CONCLUSIONS

With the recognition of incorrectness of the previously used numerical data for calculating safety screens, naturally there arises the necessity of deriving, as far as possible from experimental results, their

correct values. In the present case, we have the correct physically measured recommendations for lead screens for various voltages of Glocker and his coworkers, also embodied in the U. S. Bureau of Standards Handbook No. 15.

But, as the result of the preceding discussion, we have found that under ordinary conditions, the radiation doses transmitted through these screens may be on an average 2.1 times as large as the doses they are assumed to be, *i.e.*, in respect to their biological effectiveness as it compares with the transmission measurements made with ionization chambers behind lead screens. In order, therefore, to attain the desired protective screening in all cases, it is necessary to reduce the stray radiation intensity to about one-half in order to be assured of the absence of radiation injury.

From the data of Kaye and Berthold we have absorption coefficients in lead at various thicknesses and of radiations of various voltages (Table I). From these we can calculate the increase in lead thickness required to obtain the desired reduction in the intensity of the stray radiation.

The radiation intensity transmitted through a filter is equal to

$$I_0\, e^{-\mu x}$$

where I_0 is the intensity of the incident radiation, μ the absorption coefficient, x the thickness of the absorber, e equals 2.70.

Utilizing, therefore, the data given in the table, and with the aid of the following equation, we can find the lead thickness required to reduce the stray radiation intensity to $^1/_2$ of that which is now recommended and considered as standard. Utilizing, for instance, the data from the table for 200 kilovolts

$$\frac{\text{intensity through } 4.0 + x \text{ mm. } Pb}{\text{intensity through } 4.0 \text{ mm. } Pb} = \frac{e^{-\mu x}}{e^{-.1\times 28}} = \frac{e^{-\mu x}}{e^{-11.2}} = e^{-\mu x + 11.2} = e^{-.7}$$

From this we obtain $\mu x = 11.9$; since from Kaye and Berthold's tables, we have $\mu = 25$.

$$x = \frac{\mu x}{\mu} = \frac{11.9}{25} = 4.75 \text{ mm. of lead.}$$

Column 4 of Table I gives the increases in lead thickness found necessary, which leads to the result that in order to be certain of the expected protection safety against stray radiation, there is required an increase of lead thickness of approximately 20 per cent to 25 per cent.[4]

Figure 2 shows curves of the old and the new values of lead thicknesses for protective screens. These agree quite closely with the author's earlier recommendations.

Discussion.—The final and probably the most important discussion should be one dealing with practically valuable results. Hence, the measurement and discussion of the stray radiation intensities around x-ray tubes employed in actual diagnostic work might be particularly suited to demonstrate and establish the actual importance and practical value of the corrected protection specifications.

With this end in view, the stray radiation intensities near several x-ray tubes was measured for the purpose of concluding upon the adequacy or sufficiency of the provided protection features. Evidently, from what we have seen in the aforegoing, we can make a comparison of the stray radiation intensity from an internally protected x-ray tube against that from a non-protected tube housed in a conventional protective lead glass bowl, or we can determine the distance required from the tube at which the accepted safety tolerance dose in its corrected form is not exceeded.

Figure 5 is a cross-sectional outline of an internally shielded or protected type

[4] From the lead absorption curves of Herrmann and Jaeger (Fortschr. a d. Geb. d. Röntgenstr., 1930, XLII, 115) it is found that in order to obtain a similar decrease of the stray radiation intensity with 220 kilovolts, a lead thickness increase of about 30 per cent must be made.

of x-ray tube. Figure 3 shows a similar outline of a non-protected tube which is supported in a conventional lead glass bowl, and Figure 4 is a cross-section of the same tube but in a plane at 90° from that of Figure 3. On the diagrams are entered the radiation intensities measured at given distances when the tubes are operated at 80 peak kilovolts and 10 milliamperes of pulsating tube current.

These intensity measurements were all made with the same dosage instrument employed for the determination of the original safety tolerance dose and all the other data reported in this paper. These data, therefore, are in particular truly relative to the stray doses reported, and hence fully in terms of the original tolerance dose. The same measurements were then repeated with the ionization chamber covered with 0.25 mm. of copper as a filter for the stray radiation. The readings obtained are given in Table II and they are also entered on the diagrams, the figures being surrounded by brackets. These results, shown in Columns 4, 7, and 10 of Table II, definitely indicate that the stray radiations, when different methods of protection are applied, are not of the same composition and also that their composition differs in the various directions from the x-ray tube. Therefore, the intensities as measured by ionization, without regard to the composition of the beam, cannot be taken as reliable indication of the tolerance dose. Therefore, in order to be safe against all possible kinds of stray radiations, we categorically have to increase the protective values of all protective devices by about 50 per cent.

In order to arrive at a decision regarding the sufficiency of the protection, it is required to know the total radiation produced in the tube during the period of one month. In several busy x-ray departments of large hospitals in New York City, the total number of exposures, their duration, and the tube current used during each, were tabulated. The largest value recorded was 18,000 milliampere-seconds in one day, which makes 3.54×10^5 ma.-sec. per month. With an average tube current of 10 ma., the time is 3.54×10^4 seconds. The greatest stray radiation intensity back of the tube (operating with 10 ma.), shown in Figure 5, is 11.7×10^{-5} r/sec. This makes in one month a total dose of stray rays of $11.7 \times 3.54 \times 10^{-1} = 4.14$ r/month. This is at a distance of 40 cm. from the radiator of the x-ray tube.

From Figure 1 we find that a tolerance dose of $^1/_{100}$th of an erythema dose would be 4 r/month. Reducing this intensity to 50 per cent, as is required, makes the safe tolerance dose equal to 2 r/month.

With the inverse square relation we find that at the distance of

$$X = \sqrt{\frac{40^2 \times 4.14}{2}} = 57.3 \text{ cm.}$$

from the radiation of the tube the safety tolerance dose is not exceeded.

Calculating in a similar way the stray intensity on the side of the tube, we find that 3.55×10^{-5} r/sec. in 3.54×10^4 sec. gives a total dose of 1.26 r, which, at a distance of 50 cm. from the center of the x-ray tube, is still lower than the permissible tolerance dose of 2 r per month.

The ratios of the full radiation intensities, divided by the filtered values measured (through 0.25 mm. Cu), given in Column 4 of Table II, show fair constancy, which indicates that from the internally shielded tube, great variations in the composition of the stray radiation are not present. Calculations similarly made for the non-shielded tube in a conventional lead glass bowl reveal that alongside of the bowl but still below a plane through its upper brim, the stray radiation dose is not in excess of 2 r/month. However, above the brim of the bowl or endwise in a plane through the slots, the stray radiation intensities are very highly non-homogeneous, which is indicated by the great variation of the non-filtered and the filtered intensity ratios given in Columns 7 and 10 of Table II; but then the intensities of stray rays are considerably larger than the safety tolerance

dose—in some directions about a hundred times the permitted intensity for the safety tolerance dose.

SUMMARY

1. X-ray over-radiation injuries are of two kinds—external or skin lesions and internal or blood and organic changes.

2. Physical measurements of Behnken, Glocker and their associates, while physically correct, cannot be employed directly for the final determination of the thickness of protective screens.

3. The composition of the stray radiation has an important bearing on the biological effects:

(*a*) for the reason that different wave lengths require different numbers of r for an erythema, and

(*b*) because short wave length filtered rays have smaller surface, but larger effects on internal organs, blood, etc.

4. The safety tolerance dose was originally determined for a stray radiation of mixed wave lengths; hence, transmission values measured through lead screens have different biological effects.

5. For unknown mixtures of stray rays, the stray doses should be about 50 per cent, so that in all cases the assumed or accepted safety tolerance dose is not exceeded.

6. The thicknesses of lead screens determined from physical measurements should be increased in order to provide in all cases that safety which they are assumed to give.

7. It is experimentally shown that stray radiations are heterogeneous and, hence, that the recommended thickness increases for protection screens are justified.

8. The actual thickness increases necessary are calculated and represented in a curve for various voltages.

9. It is shown that the stray radiation from an internally shielded x-ray tube is relatively homogeneous; *i.e.*, full stray radiation + filtered stray radiation = small ratio.

10. It is also shown that stray radiations reflected from glass shields, wood, etc., are highly heterogeneous; *i.e.*, full stray radiation + filtered stray radiation = large ratio.

11. It is pointed out that internally shielded x-ray tubes offer very much safer protection than non-protected tubes housed in conventional lead glass shields.

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(9) *Loc. cit.*

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

ROENTGEN DIAGNOSIS IN PRIVATE PRACTICE[1]

The tremendous increase in the use of the roentgen ray in diagnosis is a striking development of modern medical practice. In a recent survey we found that some 55 per cent of all the patients admitted to the University Hospital came to the x-ray department for some diagnostic procedure. At the Mayo Clinic it has been estimated that about 80 per cent of the patients have some form of x-ray study during the course of their examination. In no disease is the need for adequate roentgen examination more vital than in carcinoma of the stomach and in pulmonary tuberculosis. In these two serious conditions early diagnosis is of the utmost importance and an early diagnosis is possible in a very high percentage of the cases by the roentgen method.

It is, therefore, significant and tremendously disappointing to consider the following data. In a survey of 100 cases of carcinoma of the stomach, only 26 had had x-ray examination before entrance into the hospital. Of these 26, only four had been diagnosed correctly, while in the other 22 the diagnosis was either doubtful or negative. In a larger series of cases suspected of having pulmonary tuberculosis the results of x-ray examination were almost as bad, except that here the errors were mostly on the positive side. When it is considered that in competent hands the x-ray diagnosis of carcinoma of the stomach can be made correctly in at least 90 per cent of the cases, and in pulmonary tuberculosis the accuracy is even greater, it can be realized that there is need for an increase in the quality as well as the quantity of our x-ray examinations.

Roentgenology is a specialty in medicine. It has been so recognized by the American Medical Association for a number of years. The recent organization of an American Board of Radiology for the purpose of certification by examination of qualified practitioners in this field is the final step in the development of this specialty. The purpose of the Board is to raise the standards of training and qualifications of the physicians who are practising roentgenology or radiology as a specialty, and thus to raise the quality of the roentgen examinations which are done. Unfortunately, only a very small part of this purpose can be accomplished in this way. The fact is that the vast majority of the x-ray examinations of patients are made by general practitioners, internists, surgeons, or specialists in other fields, rather than by roentgenologists.

In this matter of who shall make the x-ray examination of Dr. John Doe's patient, there is the most striking discrepancy between group or public practice and individual or private practice. In this country to-day, if a patient comes to a municipal or a federal hospital, to a public clinic, or, in the vast majority of cases, to a private clinic or private hospital, he will have his roentgen examination attended to by a well trained specialist in this field, by a man who is devoting all his time to this complex and difficult subject. If, however, this patient presents himself to Dr. John Doe's office, he may have this examination done very differently. It may be done by Dr. Doe himself, although the only qualification the Doctor may possess is that some supersalesman sold him an x-ray machine. It will frequently be done by his office partner who may have more experience, having possessed his x-ray machine for a longer period of time and having examined more patients during this period of time. Occasionally Dr. Doe is a specialist himself in the field in which the patient's complaints lie, or he may send the patient to a gastroenterologist, a chest specialist, or some other specialist. In that event the examination may be done by the specialist, who will usually be better qualified than the general practitioner. Finally, and in the minority of cases, the patient will be sent to a roentgenologist and get the same expert examination that he would have obtained if he had been sent to a hospital, whether municipal or private, or had gone to a free clinic.

The cases referred to at the beginning of this

[1] Reprinted by permission from the "Bulletin of the Hennepin County Medical Society," April 10, 1934, V, 44.

discussion came almost exclusively from small rural communities. The x-ray examinations were done in the vast majority of instances by general practitioners to whom no expert roentgenological service was available. No criticism of these physicians is justifiable in spite of the poor results of their roentgen diagnostic work. They are doing the best that can be expected of them under difficult conditions. But what excuse is there for this type of work in a large city where adequate x-ray consultation is readily available? Numerous reasons have been given for Dr. Doe's purchase of an x-ray machine and his efforts to do his own x-ray work. The most frequent of these reasons is the matter of expense to the patient. Dr. Doe says that this examination costs the patient much less than would that of the roentgenologist and his patients are not wealthy and cannot afford any luxuries. As a matter of fact, this is not true. There is every reason to believe that a specialist in this field doing a considerable amount of work in it all the time can do it more cheaply than the practitioner who does only an occasional case. The difference in cost is only apparent. It is due to the fact that Dr. Doe is willing to make an examination of poor quality, to do a fluoroscopy where films are indicated, to take one film where many are necessary, etc., and also to the fact that Dr. Doe is not charging the patient for his services in this examination. This is perhaps justifiable in view of the fact that his services in this regard are frequently worth nothing. The patient may pay less in money, but his proportionate return is usually even less.

There would seem, in many instances, to be some plausible excuse for a man practising a rather restricted specialty, such as orthopedics or urology, to do his own roentgen examinations. There are numerous factors, even under these conditions, which militate against the patient obtaining the best results from such an examination, but what reasonable excuse there is for an internist, a general surgeon, or a general practitioner in a large city to practise roentgenology as a sort of side line is difficult to see. It leads inevitably to poor roentgenologic work, it is deleterious to the best interests of the patient, and certainly leads to no good for the medical profession. As our sociologists and publicists who are agitating for a change in the form of medical practice contemplate the difference between the methods of x-ray examination in group practice and in private practice and also observe the corresponding difference in the quality of the examination, they may certainly be pardoned for some skepticism as to the benefits of the individual practice of medicine, at least in this one regard. A proper regard for the best interests of the public and of the medical profession itself should lead to a different method for conducting x-ray examinations in private practice.

LEO G. RIGLER, M.D.

COMMUNICATIONS

THE FIRST DEEP ROENTGEN THERAPY: PRIORITY FOR THE TREATMENT OF LEUKEMIA[1]

A REPLY TO DR. W. A. PUSEY

By U. V. PORTMANN, M.D., *Cleveland Clinic, Cleveland, Ohio*

I have studied with interest the comments of Dr. W. A. Pusey entitled "The First Deep

[1] The following correspondence took place between Dr. Portmann and Dr. Pusey following the publication of the latter's paper. It is self-explanatory.

Letter Submitting Manuscript to Dr. Pusey

March 17, 1934

DR. WILLIAM A. PUSEY,
7 West Madison Street,
Chicago, Illinois.

DEAR DR. PUSEY: I was very much interested in your comments on the first deep roentgen therapy which appeared in the January number of RADIOLOGY. I have reviewed the whole subject again, and have prepared a short answer to your criticism which I am going to send to the Editor of RADIOLOGY. I am sending a copy to you first, however, and should appreciate it very much if you could go over it and send me any criticisms, comments, or suggestions. I am holding the copy for RADIOLOGY until I hear from you.

With kind regards and all good wishes, I am

Yours very truly,

U. V. PORTMANN, M.D.

Dr. Pusey's Reply

April 5, 1934

DR. U. V. PORTMANN,
9204 Euclid Avenue,
Cleveland, Ohio.

DEAR DR. PORTMANN: Thank you for sending me your comments in reply to mine on the subject of the first deep roentgen therapy. I should have replied to you sooner but I have been out of the city.

Radium Therapy," in the January, 1934, issue of RADIOLOGY, concerning statements made in the chapter on "*Roentgen* Therapy," which I wrote for "The Science of Radiology." Although Dr. Pusey's communication appeared as a surprise to me, his comments are appreciated because I recognize his preëminent distinction and the inestimable value of his primigenious contributions to roentgen therapy.

It must be obvious that there were difficulties involved in writing such a brief chapter on the comprehensive subject of roentgen therapy. There were limitations of time and space which prevented detailed explanations and prohibited a complete bibliography of the numerous publications reviewed. It was a precarious task to select and cite the publications which dealt with the question of priority and, at the same time, to avoid expressing the opinion of one individual. Therefore it is stated in the first paragraph of the chapter, "I do not presume to be an authority on the debatable question of priority." Every effort was made to give the evidences as they appear in a general survey of the literature.

According to the general consensus of opinion, priority for an accomplishment is estab-

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I confess I do not see the validity of your position that Senn is entitled to the credit for priority because he reported the first *successful* treatment of leukemia with x-rays. But I do not believe that even that contention can be maintained, for in my book on Roentgen Rays, published on June 1, 1903, I reported a case of leukemia which had been treated successfully in the same sense that Senn had successfully treated his case, reported in August, 1903. This was a case of leukemia whose treatment began March, 1901, and continued for more than one year, in which there was disappearance of many glands, decrease in size of the spleen, reduction of white corpuscles from 74,000 to 12,000, and great improvement in the patient's general condition. This case is described in some detail on page 552 of the first edition of "The Roentgen Rays in Therapeutics and Diagnosis," Pusey-Caldwell. The diagnosis was made by Dr. Jacob Frank, Dr. Frank Billings, and others. At the same time I reported the death of the patient later, but that undoubtedly happened with Senn's patient, as it did with all other leukemia cases. For more than a year before, as I recited in my previous comments, these cases of lymphoblastoma were being treated by many men and the method of treatment was well recognized.

I cannot see the force of the comment, in this connection, that leukemia is a very different thing from pseudoleukemia. The clinical and the essential similarity between the two diseases is so close that it was inevitable that as soon as pseudoleukemic masses had been cleaned up with x-rays, the treatment would be tried in leukemia. I and many others did it.

As to the point that Senn reported a successful result and the rest of us did not, that would simply seem to be penalizing conservatism. All of the rest of us reported the disappearance of lymphoblastomatous tissue under x-rays. We reported the facts, which were symptomatic improvement and symptomatic cures, but we, it would seem properly, restrained ourselves from making any further claims. In Senn's case, reported as successfully treated, the only difference was in the claim.

As far as our being at least agreed that I had nothing to do with Senn's case, the same also may be said almost literally of Senn. If any persons should be given credit in Senn's case, they are the member or members of the house staff of St. Joseph's Hospital who suggested the use of x-rays to Senn in his first case of pseudoleukemia, and Dr. W. F. Buttermann, of St. Joseph's Hospital, and Dr. Joseph F. Smith, of the Presbyterian Hospital, the roentgenologists who carried out the treatment of his cases of pseudoleukemia first, and then of his leukemia case. They are the "mute, inglorious Miltons" in this situation. In Senn's reports he makes no reference to the work which had already been done with x-rays in these cases. The most satisfactory explanation of this omission is that the method had become so well established that he thought reference to this fact was unnecessary. This is supported by his statement that "I prescribed, as usual, arsenic and iron, and, in view of the heretofore hopelessness in such cases, advised, in addition, the use of the roentgen ray." This matter-of-fact statement of the advice of x-rays in the case would indicate that he assumed that the use of x-rays in such cases had become a method of treatment sufficiently well recognized to require no comment. He would otherwise hardly have picked so unusual and original a treatment of leukemia out of the air, as it were, without explaining the reasons for so doing.

I would be glad if these comments could be published with your letter.

Yours sincerely,

W. A. PUSEY, M.D.

Letter Replying to Dr. Pusey

April 18, 1934

Dr. WILLIAM ALLEN PUSEY,
7 West Madison Street,
Chicago, Illinois.

DEAR DR. PUSEY: Thank you very much for your letter of April fifth in regard to our discussion. I am sure that if you go over my article again *you will find that I make no statement, but only give historical facts as published in the literature.*

Of course, there is evidence that leukemia was treated by roentgen rays prior to the case of Senn. However, I think that it should be left up to the readers to try to decide if they wish to take any definite stand.

I shall send your letter to Dr. Menville, the Editor of RADIOLOGY, and he can use it as he sees fit.

Thanking you again for writing, and with regards, I am,

Yours very sincerely,

U. V. PORTMANN, M.D.

lished on the basis of the earliest report of success or of positive results. To show that priority is actually properly accredited in the chapter on the points which Dr. Pusey questions, let me quote from it: "Those who first reported their success and are generally given credit by authorities for priority in treating various conditions are as follows: leukemia and lymphadenomas, Pusey and Senn, 1903." In addition, the early, admirable publications of Dr. Pusey, and those of others, on Hodgkin's disease (lymphadenoma) as well as other conditions, are cited on pages 222 to 224.

Dr. Pusey brings out one point in his communication, the accuracy of which cannot be disputed, when he writes that he "had nothing to do with the x-ray treatment of Senn's cases." For having repeated this mistake, which is made in a number of publications, I wish to express my regret. The error might have been avoided had there been time enough to corroborate each detail by personal communication with the living authors whose work was discussed.

Dr. Pusey states in his communication in RADIOLOGY: "Previous to the time of Senn's report the following reports of cases of leukemia and pseudoleukemia treated with roentgen rays, in some cases with symptomatic cure, had been made." That Dr. Pusey and others wrote on pseudoleukemia prior to Dr. Senn's work on leukemia is well established in the chapter, as shown by the large bibliography listed which includes most of the references which Dr. Pusey cites in his comments.

The point about pseudoleukemia (Hodgkin's disease, lymphadenoma) having been agreed upon, let us now study the articles which Dr. Pusey gives in his comments in order to determine whether or not they confirm his contention that the authors report favorably upon the roentgen treatment of leukemia prior to the publication by Dr. Nicholas Senn of his paper, "A Case of Splenomedullary Leukemia Successfully Treated by the Use of the Roentgen Ray" (Med. Rec., Aug. 22, 1903, LXIV, 281). As far as I have been able to ascertain, and according to others who undoubtedly have searched the literature with equal thoroughness, this was the earliest specific report concerning leukemia that included clinical details satisfactorily proving successful roentgen treatment.

The first article to which Dr. Pusey refers as evidence that there were "reports of cases of leukemia and pseudoleukemia, treated with roentgen rays," prior to Dr. Senn's article is, his own publication "Cases of Sarcoma and Hodgkin's Disease Treated by Exposures to X-rays—A Preliminary Report" (Jour. Am. Med. Assn., Jan. 18, 1902, XXXVIII, 166–169). This reports the treatment of three cases of sarcoma and two cases of Hodgkin's disease, but there is no mention of leukemia.

Dr. Pusey's second reference is to his article, "Report of Cases Treated with Roentgen Rays" (Jour. Am. Med. Assn., April 12, 1902, XXXVIII, 911–919), a discussion of 36 patients with several different diseases, including the cases of pseudoleukemia and sarcoma previously reported. In a short paragraph on leukemia an additional case is mentioned and the author states: "I have exposed one case of splenic leukemia to x-rays. She was given x-ray exposures over the spleen for a month with no effect whatever. . . . In my judgment the case shows nothing." There is no statement about any favorable results.

The next publication that should be reviewed although not mentioned in Dr. Pusey's recent communication, is his own book, written in collaboration with Eugene Caldwell, entitled "The Roentgen Rays in Therapeutics and Diagnosis," first published in June, 1903, by W. B. Saunders Co., Philadelphia. The authors discuss "two cases of true leukemia" on page 552. Dates are not given in the history of the first case, but it is apparently the patient previously reported by Dr. Pusey as of April 12, 1902, and the statement made in that article is repeated in the book. "She was given x-ray exposures for a month with no effect whatever." The second patient seems to have had lymphatic leukemia. They say, "the disappearance of the tumors was in close sequence with x-ray exposures," and in the discussion of the case it is said that the patient did not continue treatment long enough. There is no statement about a favorable result; as a matter of fact, the blood counts tabulated show that the number of white cells increased from March to September, during the course of treatment.

These publications by Dr. Pusey indicate that, although he treated leukemia by roentgen rays before 1903, he did not believe that there was any benefit, but, on the contrary, observed "no effect whatever," and so reported.

The third article referred to by Dr. Pusey,

"The Use of X-rays in Cancer, Lupus, and Hodgkin's Disease," by F. W. Hett (Dominion Med. Monthly, August, 1902, XIX, 76–80), is a report of the roentgen treatment of seven cases, including one of Hodgkin's disease, but there is no mention of leukemia.

Dr. Pusey's fourth reference is the article by Dunn, "The Therapeutic Uses of the X-ray, with Report of Cases" (Am. Pract. and News, Oct. 1, 1902, XXXIV, 263–275), in which the author tells of his experience in the treatment of 23 cases, including one of "pseudo-leukemia (Hodgkin's disease)," but does not mention leukemia.

In the article "Cases Illustrating the Therapeutic Uses of the Roentgen Rays," by S. B. Childs (Medical News, Jan. 24, 1903, LXXXII, 145–149), to which Dr. Pusey also refers, the author states: "It includes six cases of epithelioma, one of carcinoma, three of lupus erythematosis, one of chronic eczema, one of tubercular glands, one of tuberculosis pulmonalis, and one of Hodgkin's disease." There is no report on leukemia.

Dr. Pusey's last reference is to "Williams' book on 'Roentgen Rays,' published about March, 1903." There were three editions of "The Roentgen Rays in Medicine and Surgery," by Dr. Francis H. Williams (The Macmillan Co., New York). The first edition appeared in 1901 and was the first American text-book on the subject. The second edition was prefaced and appeared in 1902, and the third in 1903 and is more comprehensive than the others. Dr. Pusey in his communication refers to the last (1903) edition. In none of them is leukemia mentioned in the bibliography, the index, or the text. The only conceivable reference to leukemia is in the second (1902) edition, in which there is an addenda slip inserted (page 225) which lists a few diseases treated by Williams, among them "some forms of enlarged spleen." However, in the third edition (1903) even this indefinite reference is entirely lacking. In both the second and third editions of Williams' book, Dr. Pusey's cases of sarcoma and Hodgkin's disease are discussed and the bibliographic references given are to the two articles herein mentioned.

It is undoubtedly true that leukemia had been treated by roentgen rays before Dr. Senn's trial of the method, but no one seems to have reported favorable results and Dr. Pusey's references do not prove that the treatment of leukemia was successful "a year before Senn made his report," nor that there were other reports to this effect. Let me repeat that this does not apply to pseudoleukemia (or Hodgkin's disease, lymphadenoma), which is entirely different in its clinical and anatomic pathologic manifestations.

Let me now explain the reasons for the following statement, to which Dr. Pusey seems to object, *i.e.*, "Dr. Nicholas Senn, of Chicago, really founded deep roentgen therapy when he reported favorable results from roentgen irradiation of the spleen in patients suffering from leukemia. This latter report proved that roentgen rays had deep effects," etc. This was not an expression of my own or any one individual's personal opinion.

I grant that the question as to when, how, or by whom "deep" roentgen therapy was founded is debatable. One might contend, with some justification, that the very first attempts to use the rays therapeutically in 1896 were the beginning of deep therapy, but this is not generally conceded. For example, there were trials at treating pulmonary tuberculosis and Despeignes treated carcinoma of the stomach at that time, and in the next few years of earnest investigation the rays were applied empirically for a great many different diseases, including deeply located lesions. But it is obvious, as one reviews the early literature, that up to about 1903, success with roentgen therapy was reported only in skin diseases, superficial ulcerations, or neoplasms. Apparently little credence was given to a few sporadic claims of benefits to deeply situated lesions, because these observations were based mostly upon unreliable subjective statements and were not accepted as conclusive evidence of the beneficial effects of radiation.

Undoubtedly deep roentgen therapy was gradually evolved, but was given a great impetus by certain clinical and laboratory findings among the first of which seems to have been the report of the reliable clinical observations of Dr. Senn. This detailed discussion by such a celebrated physician was interpreted by many individuals as an indication that roentgen rays had sufficient penetration to be therapeutically effective to internal organs, because he said that the size of the spleen was reduced and the white blood count was diminished in a patient with leukemia. Experimental laboratory evidences were also presented in 1903 by Albers-Schönberg, who

produced aspermia in rats, and by Heineke, who discovered "the selective action of the rays upon lymphatic tissues and suggested the possibility of therapeutic application in certain diseases of the lymphatic system, including leukemia, which, unknown to him, had just been reported by Senn in the meantime."

Perthes also made a remarkable contribution when he reported, in 1904, on "the rate of absorption of roentgen rays in tissue" and found that "when the rays are filtered through aluminum the skin is protected and the intensity into the deeper layers is increased." It was Perthes' experiments that suggested the physical background of *homogeneous cross-fire* therapy, promptly advocated by Dessauer.

It cannot be denied that all of these investigations were significant in founding deep roentgen therapy and the first of them was the clinical observation by Senn. Perhaps Senn's article was not of consequence in the minds of some individuals, but others considered the report to be of signal import, especially in relationship to these other contemporary discoveries.

To illustrate the influence and significance which Dr. Senn's article had, especially abroad, permit me to translate and quote from two of many authoritative publications by contemporaries. Oudin and Zimmern, in France, said: "The first to utilize the x-rays in the diseases of the leukemia group were Pusey and Senn. The publication of Pusey (1902) passed unnoticed. He reported a case of pseudoleukemia relieved by the rays and failure in a case of myelogenous leukemia with splenomegaly. In the following year, Senn, of Chicago, published two favorable observations which were received with astonishment but did not convince, because it was impossible to believe, at that time, that an external treatment could have any effect upon blood changes, etc." (Radiotherapie, Roentgenotherapie, Radiumtherapie, Phototherapie. P. Oudin and A. Zimmern, J. B. Baillière et Fils, Paris, 1913, pp. 285, 286).

Prof. G. Holzknecht, another contemporary from Austria, wrote: "In 1902 (*sic*) the medical world was startled by the really astonishing communication of the American physician, Nicholas Senn, of Chicago, who reported that it had been possible not only to change the blood picture and to reduce the size of the spleen and enlarged glands in a case of leukemia by x-radiation, but also to improve the serious condition of the patient. At first this news was almost incredible, because up to this time it was unknown that the x-rays had an effect upon internal organs. Senn's communication gained credence when he also told about two cases of pseudoleukemia which had been treated with equal success, and when Albers-Schönberg (1903) reported the curious fact that aspermia had been produced in experimental animals by x-rays. Senn, therefore, seems to have been the founder of deep roentgen-ray therapy." A biography of Nicholas Senn is given and the discourse continues: "In his own country there is disagreement. But there is no question about the historical significance which these two publications had upon the whole medical world. However, this is not the opinion of American physicians—where Senn is not considered to be the founder of deep therapy and is not given credit because such trials had been made prior to his but had not been published." (Lehrbuch der Strahlentherapie, Urban & Schwarzenberg, Berlin, 1925, Chapter I, 13–15.)

Finally it has been shown from Dr. Pusey's own publications that he and others had treated and reported success in the treatment of pseudoleukemia and that leukemia had been treated prior to Senn's trial, but that no one before him had reported favorable results. Hence Pusey's report that there were "no effects whatever" did not have the same influence or historic significance as Senn's report of success. On this basis it would seem justifiable to me, and others who have previously written upon the subject, to state that Senn's report on the successful treatment of leukemia was one of the first suggestions that the roentgen rays had a deep effect hitherto undemonstrated. We may maintain with considerable satisfaction that an American is credited with being the founder of deep roentgen therapy.

I have tried to present as concisely as possible and without prejudice, the evidences from the literature as they apply to Dr. Pusey's objections and wish to thank the Editor for the privilege of publishing this detailed explanation.

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

ZURICH AND ST. MORITZ, SWITZERLAND

The Fourth International Congress of Radiology will be held at Zurich and St. Moritz, Switzerland, from July 24 to 31, under the patronage of the President of the Swiss Confederation, Dr. Marcel Pilet-Golaz. All the leading nations of the world, including the United States, will send delegations. The general program foresees meetings in the University and the Federal Institute of Technology at Zurich from July 24 to 28. There will be a delegates' luncheon on the opening day, with the Swiss Roentgen Society acting as host, also a reception and ball. A Festival of Swiss National Costumes is to be held in honor of the visitors on July 27. The trip to St. Moritz, which is bound to provide much scenic entertainment, is scheduled for July 28, on which day a reception will be tendered to the delegates by this famous Engadine resort. A final banquet will be held on the closing day.

Mme. M. Curie figures among the noted guests of honor of this Congress, and a number of American physicians will speak at different meetings.

THE NEXT ANNUAL MEETING

Among the plans now being formulated for the Annual Meeting of the Radiological Society of North America is an innovation having to do with the Scientific Exhibit. Instead of compelling the exhibitor to spend long hours at his exhibit, repeating over and over again his explanatory remarks, a new plan is under consideration. It is, in brief, to allot each scientific exhibitor a fifteen-minute period when he may make a full exposition regarding his material. Announcements will be posted upon a bulletin board giving full information relative to the time at which scientific exhibitors will be present at their various booths for the purpose of answering questions.

There will be one session only in progress at any one time, so that those in attendance may hear all the papers read, if they so desire. Each one can "listen in" on all the papers and discussions, or select those in which he is particularly interested. It is thought that this arrangement will result in uninterrupted sessions, since members of the audience will not be passing in and out to select papers from simultaneous sessions.

The Clinics that are in process of arrangement will be one of the outstanding features of our Annual Meeting this year. Such practical demonstrations will be inaugurated as to resemble closely a post-graduate course of instruction.

There will be a banquet, as in former years, for which the Local Committee is already arranging a fine program. There will also be the customary Counselors' Dinner and a Stag Night. The 1933 meeting having been a joint one with other societies, the customary procedure had to be varied, with the result that there were lacking many of the social features which have made the Annual Meetings of the Radiological Society of North America events to be anticipated with pleasure and viewed in happy retrospect. The officers and the Memphis hosts anticipate that none of these features shall be lacking from the 1934 meeting, and hope that the members will attend in unprecedented numbers.

As the plans mature, announcements will be made in succeeding issues of RADIOLOGY.

ANNUAL MEETING OF THE MEDICAL SOCIETY OF THE STATE OF NEW YORK

UTICA, N. Y., MAY 14, 15, 16, 1934

At this, the 128th Annual Meeting, the Section on Radiology elected the following officers for the coming year:

Donald S. Childs, M.D., of Syracuse, *Chairman;* Leo P. Larkin, M.D., of Ithaca, *Vice-chairman;* James M. Flynn, M.D., of Rochester, *Secretary.*

The program of the Section on Radiology follows.

Cancer of the Tonsil, James J. Duffy, M.D., New York.

Palliative Irradiation of Inoperable Gastric Cancer, George T. Pack, M.D., New York.

Cancer Research, Francis Carter Wood, M.D., New York.

Post-operative Roentgentherapy for Carcinoma of the Breast, Maurice Lenz, M.D., New York, and Haig H. Kasabach, M.D., New York.

General discussion opened by Douglas Quick,

M.D., New York and Virginia K. Frantz, M.D., New York.

Encephalography, Cornelius G. Dyke, M.D., New York.

Discussion opened by Charles W. Schwartz, M.D., New York.

Bronchography, Leopold Jaches, M.D., New York, and I. Scotty Schapiro, M.D., New York.

Discussion opened by James M. Flynn, M.D., Rochester.

Small Intestine: Major and Minor Motor Phenomena and Their Differentiation from Pathologic Lesions, Lewis Gregory Cole, M.D., New York.

Discussion opened by Donald S. Childs, M.D., Syracuse.

Low and High Power Roentgenographic Studies of the Sigmoid, William H. Stewart, M.D., New York, and Henry E. Illick, M.D., New York.

Discussion opened by Ulysses S. Kann, M.D., Binghamton.

Excretion Urography and Its Value to the Radiologist, Leo P. Larkin, M.D., Ithaca.

PROGRAM FOR ANNUAL MEETING

The Program Committee of the Section on Therapy invites papers from the membership-at-large in three Symposia for the annual meeting: (1) Malignancy of the Mouth and Neck; (2) Breast and Pelvic Viscera, and (3) Dermatology.

From present indications it would seem that it would be good policy to limit the number of papers to four in each session. This would make a total of twelve papers. Up to the date of this announcement, three papers have been offered—two on Mouth and Neck conditions and one on Pelvic Viscera.

In case more papers are received than can be accepted, the undersigned suggests that all papers be submitted to the Advisory Program Committee for selection, and those not accepted be referred to the Editor for publication in the Journal, with whatever corrections are necessary, and at such time as space may be found available.

A good and well-balanced program is the most essential feature of a scientific meeting. This can be secured only by early co-operation from the essayists. Please act accordingly.

ALBERT SOILAND, M.D.
For Section on Therapy

CANADIAN MEDICAL ASSOCIATION

The Canadian Medical Association held its meeting at Calgary, Alberta, June 20–22, 1934. The Section on Radiology was under the Chairmanship of W. Herbert McGuffin, M.D., President of the Radiological Society of North America. The program of the Section was as follows:

Wednesday, June 20

SECTION OF RADIOLOGY. *Chairman:* W. Herbert McGuffin, M.D.

Each paper, 20 minutes; discussion, 10 minutes.

DR. DIGBY WHEELER, Winnipeg: Paranasal Sinuses—Ethmoids.

P. A. MACDONALD, M.Sc., Ph.D., Winnipeg: Radiation Standards and Their Practical Application.

DR. RICHARD PROCTOR, Edmonton: Treatment of Hodgkin's Disease from a Radiological Viewpoint.

DR. H. H. MURPHY, Victoria: Epiphysitis.

Thursday, June 21

DR. GEORGE H. MALCOLMSON, Edmonton: A Radiological Study of the Development of the Spine and Pathological Changes in the Intervertebral Discs.

Symposium on the Relationship of the Radiologist to Some Phases of Medical Practice.

(1) DR. B. J. HARRISON, Vancouver: Relationship of the Radiologist to the Hospital.

(2) DR. E. E. SHEPLEY, Saskatoon: Standing of the Radiologist in the Treatment of Disease with Radium.

(3) DR. C. W. PROWD, Vancouver: Relationship of the Radiologist to Public Organizations; *i.e.*, Health Insurance Boards, Workmen's Compensation Boards, etc.

(4) DR. C. M. HENRY, Regina: Relationship of the Radiologist to the Profession.

Election of Sectional Officers and Business Meeting.

Friday, June 22, 9 A.M. to 12 M.

Dr. Max Cutler, Chicago, will conduct a Cancer Clinic.

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E. T. LEDDY, M.D., of Rochester, Minnesota
DAVIS H. PARDOLL, M.D., of Chicago
E. A. POHLE, M.D., Ph.D., of Madison, Wisconsin
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APPARATUS

Further Technical Improvement of the Body Cavity Tube and its Applicability. W. Schaefer and E. Witte. Strahlentherapie, 1934, XLIX, 298–303.

The authors describe an improved model of their roentgen-ray tube which is constructed for use in body cavities (see "Strahlentherapie," 1932, XLIV, 283). It is necessary to ground the transformer on one end. They are now attempting to increase the tube potential from 100 to 180 kilovolts. Because of the short F.S.D. it is possible to apply from 50,000 to 100,000 r per hour.

ERNST A. POHLE, M.D., Ph.D.

A New Apparatus for Ultra-short Wave Therapy. Johannes Pätzold. Strahlentherapie, 1934, XLIX, 345–350.

A new apparatus is described for treatment with electrical waves from 7 to 3.25 meters in length. The apparatus and also the circuit are shown in the illustrations.

ERNST A. POHLE, M.D., Ph.D.

A Tube with Rotating Anode and Radiation-cooling at High Temperature. Alfred Ungelenk. Fortschr. a. d. Geb. d. Röntgenstr., 1934, XLIX, 162–170.

The tube factory of the Siemens-Reiniger concern has constructed a new high capacity tube with rotating tungsten target. This is formed as a disc of about 60 q.c.m. surface, shaped to give a line-focus effect with a proper cathode and eliminating heat by radiation like the standard Coolidge tubes. The target stem is mounted on ball bearings. The capacity is 28 K.W. for 0.05 sec., 24 K.W. for 0.1 sec., 10 K.W. for 1 sec., 3 K.W. for 5 sec.; 47 rev. sec. The tube can be mounted in shock- and radiation-proof shields of the common Siemens type and be used for fluoroscopy and radiography.

HANS A. JARRE, M.D.

BONES, ABNORMALITIES

Some Further Observations on Post-traumatic Paramalleolar Ossifications, with Special Regard to Their Differential Diagnosis from Fractures. Stefano Bistolfi. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 1061–1081.

The author points out the radiologic aspects of this lesion as observed in two cases which may be important from a clinical and medico-legal point of view.

E. T. LEDDY, M.D.

The Os Acromiale and Its Differential Diagnosis. Fritz Becker. Fortschr. a. d. Geb. d. Röntgenstr., 1934, XLIX, 135–142.

The os acromiale is a persistent epiphysis of the acromion scapulæ. A survey of 240 shoulders showed this ossicle in 6.6 per cent. It is usually shown only in axial views of the shoulder and may occur on one or both sides equally often and in a variety of configurations, as it develops from two to five centers of ossification. Differential diagnosis between this anomaly and fracture is often difficult. Pseudo-arthroses occur. For differentiation one has to consider ossification due to peri-arthritis humero-scapularis, following dislocations or other trauma, in subdeltoid bursitis, "joint mice," etc. Cases of arthritis deformans interacromialis are shown and a questionable case of "os glenoidale" is reported.

HANS A. JARRE, M.D.

A Study of Sprengel's Deformity. Cesare Fava. Archivio di Radiologia, XII, Nos. 5 and 6, pp. 1024–1036.

The author describes a case of Sprengel's deformity (congenital upward displacement of the scapula) in a baby of eleven months, with some new bone formation between the scapula and the spine, accompanied by rickets. Fava offers as an explanation for the occurrence of the lesion that small bony nuclei may have become detached from the scapula or vertebræ during fetal life and developed in a muscular enclosure.

E. T. LEDDY, M.D.

BONE DISEASES (DIAGNOSIS)

Familial Neurotrophic Osseous Atrophy: A Familial Neurotrophic Condition of the Feet, with Anesthesia and Loss of Bone. E. Maurice Smith. Jour. Am. Med. Assn., Feb. 24, 1934, CII, 593–595.

An unusual condition is reported, which has not permitted classification, has been observed in two generations of a family, and has a definite history in a third earlier generation.

Microscopic examination of nasal smears and biopsy material from the lesions on the feet have been negative for acid-fast bacilli. The Wassermann reaction is negative for syphilis in all but one case. Tuberculosis and syringomyelia are readily eliminated on clinical grounds. Leprosy has been given serious consideration but was excluded because of the absence of manifestations elsewhere than on the feet and the uniformity of the type of manifestations in all members of the group.

CHARLES G. SUTHERLAND, M.D.

THE BRAIN

Cerebral Cysts. Winchell McK. Craig and James W. Kernohan. Jour. Am. Med. Assn., Jan. 6, 1934, CII, 5–11.

Between 10 and 15 per cent of the surgical conditions of the brain were found to be cystic. This particular group of conditions involving the cerebral hemispheres has been divided into congenital, inflammatory, traumatic, parasitic, and neoplastic types. Congenital cysts may be subdivided into porencephalic, epidermoid, and simple. Porencephalic cysts either communicate with the subarachnoid space and the ventricle, or extend so deeply into the brain that they cause distortion of the ventricular outline. The walls of epidermoid cysts are lined with epithelium in which there are few glandular structures and the contents are not fluid, but caseous. Simple cysts are subcortical cavities containing clear fluid, with no evidences of neoplasm or inflammation.

Inflammatory cysts are rare and consist either of collections of fluid in the chronically inflamed piaarachnoid space or subcortical collections of fluid associated with chronic cephalitis.

Traumatic cysts may be divided into subdural hematomas, calcified, and simple cysts. Subdural hematomas occur between the dura mater and the cortex of the cerebrum. Calcified cysts are frequently the result of a subcortical hematoma, and are encountered at an age when spontaneous hemorrhages are not likely to occur. Smooth-walled cysts have been encountered following a definite history of trauma; these contain clear fluid and there is no evidence of neoplasm in their walls.

The most common parasitic cysts are the echinococcus; these may be solitary and frequently contain daughter and granddaughter cysts and may occur subcortically, or they may be attached to the meninges.

The neoplastic cyst is by far the most common type encountered at operation. Almost all types of tumor have been found associated with cysts; the more benign and slow-growing types seem to have a greater tendency to degenerate and form cysts than the more rapidly growing ones.

A less important group of cysts, encountered among elderly patients, comprises those associated with arteriosclerosis. They are liquefied infarcts in which absorption of the débris has been completed, and contain clear fluid. Blood pigment is often found in the walls of these cavities.

Case reports with roentgenographic and ventriculographic findings are given in detail.

CHARLES G. SUTHERLAND, M.D.

CANCER (DIAGNOSIS)

Development of Carcinoma in Fistulas of Chronic Osteomyelitis. Hans Hellner. Fortschr. a. d. Geb. d. Röntgenstr., 1934, XLIX, 109–117.

Development of carcinoma in a chronic osteomyelitic fistula or in tuberculosis of bone is rare. Three cases are reported, which developed after years of chronic discharging sinuses. Roentgenograms show a quickly progressive rarefaction in the sclerotic bone surrounding the sinus. Clinically, exacerbation of pain, with increase of a foul discharge, are arousing suspicion. Early histologic examination of curettings are essential. Chronic inflammatory disturbance of epithelial regeneration is regarded as responsible for the genesis of the malignant degeneration. Early amputation is advisable.

HANS A. JARRE, M.D.

CANCER (THERAPY)

The Influence of Syphilis on the Radiosusceptibility in Radium Therapy of Uterine Carcinoma. H. O. Kleine. Strahlentherapie, 1934, XLIX, 415–421.

The author analyzed the histories of 20 patients who received radium therapy for carcinoma of the cervix and 2 patients treated for carcinoma of the fundus. In all 22 patients, the diagnosis of syphilis was made beyond doubt. It appeared that this type of case is apt to develop injuries of the bladder and colon, often leading to fistula. The author believes, therefore, that patients with syphilis are more susceptible to irradiation and recommends that the technic of application should take cognizance of this fact.

ERNST A. POHLE, M.D., Ph.D.

Cancer Therapy with Lightly Filtered Radium. P. Feldweg. Strahlentherapie, 1934, XLIX, 291–297.

The author compared the surface and depth doses of radon screens filtered through 0.2 Ag + 1.0 Al and through 0.2 Ag + 1.0 Br. He found that with the Ag-Al screen the dose at 2 cm. distance was 375 r in 24

hours; with the Ag-Br screen it was only 348 r in 24 hours. Since at the same time with the heavier filter the surface dose is very high, the author used the Ag-Al screen in 120 cases of intra-uterine applications. During four years' observation this method has appeared to be entirely without danger, and, therefore, he recommends this technic.

ERNST A. POHLE, M.D., Ph.D.

Tumor of the Granuloma Type in the Chest. Georg Steiner. Strahlentherapie, 1934, XLIX, 351–356.

The author relates the history of a woman 48 years of age, seen in 1929, with a large mediastinal tumor suggestive of Hodgkin's disease. There was no enlargement of lymph glands or spleen. Technic of treatment: 175 K.V., 0.5 Zn + 2 Al, 2 anterior and 1 posterior field of 20 × 20 cm., at 30 cm. F.S.D., 55 per cent E.D. over each area. Two months later a second series was given and $5^1/_2$ months later a third series. The tumor disappeared, the patient gained weight, and early in 1930 a fourth prophylactic series of treatments was given. A recurrence in the right upper lobe developed in July, 1931, which was treated. In July, 1932, a very small supraclavicular gland was palpated, excised, and the diagnosis of lymphoblastoma made. There had been no recurrence in the mediastinum at the time of publishing the report.

ERNST A. POHLE, M.D., Ph.D.

The Prognosis in Adenocarcinoma of the Breast Treated by Irradiation. J. Borak. Strahlentherapie, 1934, XLIX, 263–290.

During the period 1928–1932 the author saw 17 cases of adenocarcinoma of the breast. The average period between the appearance of the first symptoms and the beginning of radiation therapy was two years; the average duration of life 41 months. A careful analysis of the entire material leads him to the conclusion that adenocarcinoma of the breast cannot be cured by irradiation. Even large doses which, however, do not cause necrosis of the connective tissue do not remove the tumor entirely. This radioresistance is in accord with the behavior of normal breast glands, which also cannot be completely destroyed unless doses are given which preduce necrosis of the connective tissue.

ERNST A. POHLE, M.D., Ph.D.

Results of Elective Therapy in Treating Carcinoma of the Cervix. F. v. Mikulicz-Radecki. Strahlentherapie, 1934, XLIX, 407–414.

After a discussion of the principles governing statistics for comparing the results of operation and irradiation in carcinoma of the cervix uteri, the author publishes his experience with the "elective" therapy. He defines this as follows: Very early cases are operated on and all others are treated by x-ray plus radium. From a study of the average data he concludes that elective therapy increases the 5-year cures by 40 per cent. He does not accept, therefore, the statement that irradiation and operation offer the patients with early carcinoma of the cervix the same chance of permanent cure.

ERNST A. POHLE, M.D., Ph.D.

Roentgen and Radium Treatment of Operable and Borderline Cases of Breast Cancer. J. H. Douglas Webster. Strahlentherapie, 1934, XLIX, 255.

The author relates his experience in the treatment of 41 cases of carcinoma of the breast by radiation alone, and in 358 cases in which irradiation followed operation. His statistical studies show that the percentage of 5-year cures can be doubled by post-operative irradiation as compared with surgery alone. Pre-operative irradiation is urged in addition to treatment after operation. The 5-year cure in 41 patients treated by irradiation alone was 66 per cent. Induration of the lungs due to the treatment can be avoided by proper technic.

ERNST A. POHLE, M.D., Ph.D.

CONTRAST MEDIA

Demonstration of the Maxillary Sinus, Epipharynx, and the Trachea with Contrast Medium. A. Zuppinger and L. Rüedi. Fortschr. a. d. Geb. d. Röntgenstr., 1934, XLIX, 176–190.

Lipiodol-filling of the maxillary antra is best obtained by puncture from the middle nasal meatus and shows well the capacity of this cavity and condition of its mucosa. It is indicated in all doubtful affections of the maxilla, especially neoplasms of the palate and alveolar process, of the nasal passages, etc., including cases lacking clinical symptoms referable to the antrum.

The epipharynx is easily demonstrated with lipiodol if views in submental-axial and lateral projections are secured on the overhanging head. All types of encroachment on its lumen are readily shown.

Demonstration of the trachea is easily accomplished after lipiodol injection into the larynx. Reliable conclusions can be drawn concerning course and lumen of this tube.

HANS A. JARRE, M.D.

DIABETES MELLITUS

A Clinical Contribution to the Question of the Value of Roentgentherapy of the Hypophysis in Diabetes Mellitus: The Effect of Irradiation on the Hydrocarbon Level and on the Blood Picture. Nicola Fucci. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 481–528.

Four cases of diabetes mellitus (in three of which the disease was pancreatic and all chance of pituitary or tubero-hypophyseal dysfunction was excluded) were treated by the method of Boschi, namely, irradiation of the pituitary through temporal fields. No result was obtained, so that Fucci contends that the idea of Vespignani that all cases of diabetes should be similarly treated (by Boschi's method) is untenable. From his study of the effects on the blood, Fucci concludes that they are an expression of a hypersympathetico-tonic syndrome from an effect on the vegetative nervous system.

E. T. LEDDY, M.D.

DOSAGE

Dosimetry in Superficial Therapy. F. Bödecker. Strahlentherapie, 1933, XLVII, 100–110.

The author gives a number of tables showing the relation between doses expressed in X and in r. Half value layers are given both for water and aluminum. The doses recommended by Meyer in the treatment of skin conditions are also tabulated; they are modernized and give all doses in r units.

ERNST A. POHLE, M.D., Ph.D.

The Measurement of High Roentgen-ray Intensities with the Integrating Small Chamber Dosimeter. Gottfried Spiegler. Strahlentherapie, 1934, XLIX, 304–308.

The author found that an integrating dosimeter equipped with the thimble type of ionization chamber does not measure high intensities accurately. He used the inverse square law in making his tests. For 60 r per minute the error amounted to 10 per cent. Although he does not wish to discredit the ionization method for determining the dose in x-ray therapy, he feels that each instrument should be more thoroughly tested by the factory and its limitations stated.

ERNST A. POHLE, M.D., Ph.D.

EXPERIMENTAL STUDIES

The Mechanism and the Value of Roentgentherapy in Small Doses in Puerperal Mastitis. G. J. Pfalz. Strahlentherapie, 1934, XLIX, 357–406.

The considerable number of patients with puerperal mastitis induced the author to study experimentally and clinically the possibility of using roentgen rays as a therapeutic agent. Mastitis was produced in guinea pigs experimentally by injection of *Staphylococcus hemolyticus aureus* into the breast. The roentgen doses amounted to 320 r (180 K.V., 0.8 mm. Cu, 36.5 F.D.). By producing bilateral mastitis and treating only one side, the author could show that irradiation therapy is of definite value. The changes of the blood immunity were studied by determining the opsonic and leukocytic index with the technic of Wright. Both were found to be increased when early stages of the mastitis were subjected to irradiation. A reaction favorable for an early healing of the inflammatory process was also seen by studies of the leukocytes. The quality of radiation had no influence on the effect. Doses under or over from 300 to 400 r were of no benefit in guinea pigs. In human therapy, the fields were 10 × 15 cm. at 40 cm. F.S.D. and a single dose of from 50 to 60 r was applied. The results obtained in the treatment of 41 cases were so encouraging that the author recommends his method.

ERNST A. POHLE, M.D., Ph.D.

THE EYE (THERAPY)

Roentgen Therapy of Absolute Glaucoma. P. Hess. Strahlentherapie, 1934, XLIX, 422–426.

The author treated 15 cases of glaucoma with roentgen rays, using the following technic: 500 r in one sitting over an anterior and a temporal field with a half value layer in Cu = 0.85 mm.; field size 4 × 4 centimeters. The dose effective in the diseased tissue should amount then to approximately 800 r. Within from 4 to 6 weeks the pain usually disappeared. It is essential that one shall use the dose recommended, since lower doses do not bring about relief. In 9 cases out of 12 with idiopathic glaucoma, radiation therapy was successful. One did not respond because of insufficient dosage; two eyes had to be removed later because of ulceration. One out of three cases of secondary glaucoma was considerably improved; two had to be operated on for cosmetic reasons.

ERNST A. POHLE, M.D., Ph.D.

FRACTURES

The Technic of Demonstrating the Nasal Skeleton in Roentgenograms. S. Grauer. Röntgenpraxis, August, 1933, V, 607–610.

For good reduction of the fragments of a fracture of the nasal skeleton, knowledge of the position of the fragments is necessary, and lateral roentgenograms of the nose have been used to get such information. The author suggests a new technic in addition; that is, a vertical direction of the central ray in the frontomaxillary direction. A large dental film (4 × 5 cm.) is put into the patient's mouth so that it extrudes for about 3 centimeters. The central ray is tangential to the frontal bone. The proximal third of the nasal bones often cannot be shown, but is usually not involved in the fracture.

H. W. HEFKE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Routine Use of Neoskoidan in Suspected Injuries to the Genito-urinary Tract. Charles M. McKenna. Jour. Am. Med. Assn., Feb. 24, 1934, CII, 599–602.

Excretory urography is a valuable asset, not only in a positive but also in a negative finding, in the early diagnosis of what is commonly referred to as internal injuries from trauma. A flat roentgenogram should first be made. In industrial surgery it is important to know whether or not the urinary tract is involved in the injury. In suspected trauma of the kidney itself, the use of intravenous urography is left to the discretion of the surgeon in charge of the injured patient. If used, it is informative as to whether the rupture is within the kidney, has extended through the true capsule, or invaded the peritoneal cavity. If extraperitoneal with a small amount of extravasation, watchful waiting and subsequent checking for any increase in size of the extravasation is the best procedure. If intraperitoneal, immediate surgical intervention is indicated.

Information regarding the condition of the opposite kidney has been made available by the excretory urogram. Rupture of the ureter may be complete or incomplete. Excretion urography will determine whether a rupture of the bladder is intra- or extraperitoneal, accurately locate the rent, and demonstrate the extent of the extravasation.

CHARLES G. SUTHERLAND, M.D.

GRENZ RAYS

New Possibilities for Grenz-ray Therapy. Julius Samek. Strahlentherapie, 1934, XLIX, 536–540.

It is possible to desensitize the human skin against artificial eczemas by exposure to Grenz rays. A total dose of 2,000 r (H.V.L. in Al of 0.03 mm.), applied in daily doses of 200 r, is sufficient. This resistance develops from three to four weeks after irradiation, and lasts for a period of from eight to ten weeks. The author bases a modification of his technic in certain skin diseases on this observation. For acne vulgaris, he uses single doses of from 100 to 200 r, up to total doses of from 1,000 to 2,000 r. Twice a week, in acne rosacea, he gives 150 r each up to a total dose of 2,000 r. A similar technic is of benefit in pruritus ani et vulvæ and lichen ruber planus. As a supplementary treatment method, Grenz rays in doses of from 50 to 100 r can be of value in the acute stage of eczema.

ERNST A. POHLE, M.D., Ph.D.

GYNECOLOGY AND OBSTETRICS

Clinical Significance of Roentgenometry in Obstetrics. Herbert Thoms. Jour. Am. Med. Assn., Feb. 24, 1934, CII, 602, 603.

External pelvimetry fails to give uniformly accurate information as to the size and shape of the superior strait. This is especially true in certain thin, undersized individuals. Although external pelvic measurements suggested a generalized pelvic contraction, roentgenograms disclosed a relatively capacious pelvis. Conversely, many thick-boned, short, squatty individuals with similar external measurements showed contracted pelves. In a relatively large group the length of the transverse diameter was so shortened as to equal that of the anteroposterior diameter. Because of the apparent relationship between a shortening of the transverse diameter and a primary or transient, and a secondary or persistent, occipitoposterior presentation, accurate information regarding the length of this diameter is of clinical importance.

If the patient is placed in a supine position, a roentgenogram of the fetal head *in utero* provides an easy method of measuring the occipitofrontal diameter, and a useful means of computing the biparietal diameter. The length of the occipitofrontal diameter may be used in determining the maturity of the fetus *in utero*.

Roentgen pelvimetry has a distinct place in the examination of every primiparous woman. It is important in the diagnosis of fetal position, the presence of fetal abnormalities, the presence of multiple pregnancy, and perhaps more especially in the diagnosis of a rachitic deformity of the sacrum.

CHARLES G. SUTHERLAND, M.D.

HEART AND VASCULAR SYSTEM

The Roentgen Diagnosis of Cardiac Aneurysms. David Steel. Jour. Am. Med. Assn., Feb. 10, 1934, CII, 432–436.

Relatively few cases have been recognized clinically. A still smaller number have been recognized roentgenologically, because they often do not produce any change in the silhouette. Usually the lesion is single, but several aneurysms can be present in one patient. Kraus described three types: (1) Those of the right sinus of Valsalva, which perforate into the right ventricle, including (*a*) congenital and (*b*) acquired. The acquired include ulcerating processes near the sinus, developing subsequent to malignant endocarditis. (2) Intravalvar aneurysms in the sinus of Valsalva. (3) Partial cardiac aneurysms, for the most part due to coronary sclerosis. Pathologically, cardiac infarcts show no essential variation from similar lesions in other organs. They have a roughly triangular outline, with the base toward the endocardium and the apex toward the epicardium.

Aneurysm can be present and give no roentgen signs. When the lesion is well developed, it appears as a sharply defined bulging of the upper portion of the left ventricular silhouette. This bulging may amount to only a slight increase in the curving of this portion of the ventricle, but it can be so well marked that an incisura is formed between it and the lower or normal portion of the ventricle. In either case the radius for the upper or aneurysmal portion is smaller than the radius for the lower or non-aneurysmal portion. Careful examination of the pulsating phenomenon early in the course of the disease might give supporting or actual diagnostic evidence.

CHARLES G. SUTHERLAND, M.D.

The Roentgen Demonstration of Calcified Coronary Arteries in Living Subjects. Paul H. Wosika and Merrill C. Sosman. Jour. Am. Med. Assn., Feb. 24, 1934, CII, 591–593.

A fairly large amount of calcium is required to interrupt enough rays to cast a shadow that can be recognized. Fluoroscopic examination, looking through the cardiac shadow rather than at the movement of the heart borders, reveals calcium deposits in the coronary sulcus. These are best seen in the anterior oblique position, but the patient should be rotated in all directions. The shadow cast is quite close to the heart border, apparently just under the pericardium. Differentiation from valvular calcification is discussed in detail. The appearance of the calcified arteries on films also is characteristic. The shadows appear linear and segmental and are curved, corresponding to the course of the artery. Other areas to be differentiated from calcified coronary arteries are: (1) pericardial calcification; (2) calcified costal cartilages; (3) bronchi behind the heart, and (4) calcified lymph nodes or nodules.

CHARLES G. SUTHERLAND, M.D.

HEMORRHAGE

Severe Hemorrhage into the Bladder: Discussion of Such Hemorrhages and Case Report of an Unusual and Almost Fatal Hemorrhage. Montague L. Boyd. Am. Jour. Surg., November, 1933, XXII, 203–206.

Sudden, severe hemorrhages into the unopened bladder are usually best treated by emptying the bladder of clots through suitable urethral instruments, and then using quite hot bladder irrigations. Electrocoagulation of the bleeding points is, however, sometimes necessary, and occasionally even suprapubic cystotomy. In old or anemic patients, radial measures should be instituted without too much delay when the hemorrhage is not readily controlled, especially if ample facilities for blood transfusions are not available for immediate use.

DAVIS H. PARDOLL, M.D.

THE HIP JOINT

Early Diagnosis and Treatment of Congenital Dislocation of the Hip. Joseph A. Freiberg. Jour. Am. Med. Assn., Jan. 13, 1934, CII, 89–93.

Three anatomic abnormalities exist in varying degrees in all congenital dislocation of the hip: unusual obliquity of the acetabular roof, annular constriction of the abnormally elongated capsule, and anteversion or antetorsion of the femoral neck.

In small infants the superior femoral epiphysis may not appear in the roentgenogram, but the break in the normally symmetrical obturator-coxo-femoral line is seen up to six months of age, and sometimes until the walking period, the dislocated femoral head lies lateral to the acetabulum and level with the superior margin of the acetabulum. A roentgen examination does not elicit abnormalities until the child is approximately five months of age.

In infancy, reduction is easily accomplished by closed or manipulative methods. Open reduction is indicated in a very small percentage of cases in which closed reduction is unsuccessful. The original manipulative reduction of Paci is still the most satisfactory method in infants more than six months of age.

CHARLES G. SUTHERLAND, M.D.

PEPTIC ULCER (DIAGNOSIS)

Roentgen Evidence of Healing in Duodenal Ulcer. Daniel M. Clark and Milton J. Geyman. Jour. Am. Med. Assn., Jan. 13, 1934, CII, 107–112.

The niche is the only pathognomonic roentgen evidence of an active peptic ulcer. Healing can be observed only in those instances in which the niche is seen and permanently recorded prior to the institution of treatment. Not over 10 per cent of duodenal ulcer niches are visible in film studies of the barium-filled bulb in the general run of cases. Berg, Akerlund, Albrecht, and others have developed a compression technic which permits accurate visualization and film recording in from 50 to 60 per cent of cases. From their own and others' experience they conclude that there is no fixed relation between niche disappearance and symptomatic relief and that niche disappearance does not simply complete healing. Contour deformities of the barium-filled bulb are of little or no value in determining the response of a lesion to treatment.

CHARLES G. SUTHERLAND, M.D.

The Radiologic Diagnosis of Duodenal Ulcer in Children. Marco Bermond. Arch. di Radiologia, 1933, XI, Fasc. 3, pp. 393–417.

The author reports a case of duodenal ulcer in a 2-year-old child in whom the diagnosis was not confirmed operatively, but who recovered on medical treatment. The roentgen findings are essentially the same as are those in adults with the same lesion. Bermond thinks that duodenal ulcer should be ruled out by x-ray examination in the obscure cases of vomiting in childhood.

E. T. LEDDY, M.D.

PERINEPHRITIC ABSCESS

Perinephritic Abscess Confused with Adjacent Osseous Lesions. E. E. Kessler, F. A. Bennetts, and S. K. Bacon. Am. Jour. Surg., November, 1933, XXII, 223–226.

Pathologic processes presenting practically all the signs and symptoms of perinephritic abscess may lie entirely outside the kidney fossa. Early, accurate diag-

nosis in such cases with our present procedures is hardly to be expected. When surgical exploration for perinephritic abscess is unsuccessful a careful consideration and diagnostic investigation of all structures adjacent to the kidney should be made. Suppuration of structures other than the kidney and perinephritic fat in this region have the same etiologic background, *viz.*, hematogenous infection from foci of suppuration elsewhere, and such cases occur with sufficient frequency to warrant their consideration in cases of suspected perinephritic abscess.

DAVIS H. PARDOLL, M.D.

PHYSIOTHERAPY

Physiotherapy for Bronchial Asthma. G. Cola. Archivio di Radiologia, 1933, XI, No. 4, pp. 709–733.

Cola prefers roentgen irradiation of the thorax, of the chest and spleen, or of the hypophysis and irradiation with ultra-violet of the chest and hypophysis for bronchial asthma in adults and in children. He thinks that treatment of the spleen alone is less valuable than the other methods. He then theorizes on the mechanism of the effect—a relief of the congestion of the bronchial mucosa, a destruction of the acidophile cells of the hypophysis, a tonic effect on the sympathetic nervous system, a desensitization of the body, a destruction of the tendency to anaphylaxis, and a re-establishment of the biocolloids.

E. T. LEDDY, M.D.

RADIATION EFFECTS

Karyological Changes of the Seedlings of *Hordeum pallidum* Following Roentgen Exposure. W. P. Tschechow and N. N. Kartaschowa. Strahlentherapie, 1934, XLIX, 238–250.

Dry seeds of *Hordeum pallidum* were exposed to roentgen rays. In the first series 100 K.V., 2 ma., and exposures beginning at 15 minutes and increasing by 5 minutes as high as 60 minutes were used. In the second series 70 K.V., with maximum exposures of two hours were chosen. It appeared that roentgen exposure of dry seeds produces karyological changes in the seedling. This may be due either to a direct effect on the chromosomes during mitosis or an effect of the radiation on the nucleus at rest. From the results of the experiments it is also concluded that a direct effect of the roentgen rays on the chromosomes is not necessary for the production of karyological changes.

ERNST A. POHLE, M.D., Ph.D.

Optic Studies on Tissue Cells. A. Smakula and H. Laser. Strahlentherapie, 1934, XLIX, 489–497.

The absorption of various tissue cells was studied with the photo-electric method between 2,300 and 3,500 Å. Normal cells from connective tissue and carcinoma cells, both taken from tissue cultures, showed two absorption bands in 2,800 and 2,600 Å. There was a difference in absorption between smooth striped cells and heart muscle cells. Normal human skin has an absorption band at 2,600 Å. which shifts to 2,800 Å. following exposure to ultra-violet rays. This shift is explained by the formation of a protective substance.

ERNST A. POHLE, M.D., Ph.D.

Experiments on *Drosophila melanogaster* Concerning the Relations between Dose and Application of Roentgen Rays and the Rate of Mutation. N. W. Timoféeff-Ressovsky. Strahlentherapie, 1934, XLIX, 463–478.

The rates of mutation produced by roentgen rays are directly proportional to the dose applied. An increase in the dose does not change the ratio between lethal and visible mutations. Subdivision of the dose has no influence on the mutation rate, and the quality of radiation is also of no influence. It appears likewise that the effect of radiation is independent of the temperature.

ERNST A. POHLE, M.D., Ph.D.

The Mechanism of the Effect of Alpha Rays. F. Herčík. Strahlentherapie, 1934, XLIX, 438–450.

The author stated in a previous publication that it requires two alpha particles to kill a bacterium. Experiments carried out on *B. prodigiosus* verified the theoretical deductions. The findings agree well with Dessauer's "Punktwärme" theory.

ERNST A. POHLE, M.D., Ph.D.

Changes in the Metabolism of Surviving Tissue Following Roentgen Exposure. A. Kahlstorf. Strahlentherapie, 1934, XLIX, 427–437.

The liver and testicles of adult white rats were exposed to roentgen rays (135 K.V., 3 ma., 23 cm. F.S.D., 3.0 mm. Al, 14.8 sq. cm. field, 600 r measured in air, 10 min.). The animals were killed immediately after the exposure and the tissues of both organs prepared for study with the Warburg method. While there was a definite increase in the aerobe and anærobe glycolysis, the oxygen consumption was definitely decreased.

ERNST A. POHLE, M.D., Ph.D.

ROENTGENKYMOGRAPHY

Pulsatory Movements of the Large Blood Vessels as Seen in Roentgenograms. Pleikart Stumpf. Röntgenpraxis, October, 1933, V, 721–732.

The movement of the large blood vessels coincident to pulsation may be shown roentgenographically best by the technic of kymography. When sphygmographic

and roentgenkymographic examinations are done simultaneously, it becomes evident that the curves of motility of the vessels correspond with the well-known sphygmographic curves. For clinical use roentgenkymography is of importance, as it allows one to differentiate between fixed and moving shadows in the roentgenogram and between arterial and venous blood vessels. Characteristic kymographic curves are usually obtained in certain organic diseases of the circulatory apparatus (insufficiencies, stenoses, calcification, passive congestion, etc.). These advantages, above those heretofore available through roentgenologic examinations indicate that roentgenkymography should be introduced as a routine examination for the diagnosis of changes in the large blood vessels.

H. W. HEFKE, M.D.

SARCOMA

An Unusual Case of Ewing's Sarcoma. O. Spitzenberger. Röntgenpraxis, August, 1933, V, 590–594.

The first roentgenologically demonstrable changes in this case of Ewing's sarcoma could be shown about four weeks after the beginning of clinical symptoms, which consisted of pain and temperature. These roentgenologic changes were not characteristic and were slight irregularities of the cortex of the femur, which could not be differentiated from periostitis or osteomyelitis. (Clinical and roentgenologic symptoms do not allow a definite diagnosis of osteomyelitis or Ewing's sarcoma at an early stage of the disease.) Four weeks later there was marked progression of the disease, the roentgenologic findings being: localization in the diaphysis, considerable extent of the process, marked sieve-like destruction of the cortex, extensive cortical apposition of new bone, definite reaction to x-ray therapy, and the occurrence of metastases.

H. W. HEFKE, M.D.

THE SKULL (DIAGNOSIS)

The Technic of Cerebral Arteriography. G. Bignami and G. Serra. Archivio di Radiologia, 1933, XII, Nos. 5 and 6, pp. 1006–1023.

The authors point out the value of studying radiologically various cerebral lesions after the injection of gaseous or opaque medium, and emphasize the advantages of encephalic arteriography. They then discuss the procedure as developed technically by various authors. Bignami and Serra favor iodomethansulphonate of sodium and discuss the technic of its use. The results they obtained are exemplified by several radiographic reproductions.

E. T. LEDDY, M.D.

Cerebral Angiography. Egas Moniz. Archivio di Radiologia, 1933, XI, No. 4, pp. 629–642.

Moniz describes his technic of injecting thorotrast into the common carotid artery to visualize the cerebral vascular system, and illustrates by radiographs some of the data brought out by this method of examination. He feels that this method furnishes valuable information in the localization of tumors and about the cerebral vascular system as a whole.

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